Report No. 25.

TENTH
ANNUAL REPORT
OF THE
SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA
1929

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY

EDMONTON:
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The Scientific and Industrial Research Council of Alberta, formed in January, 1921, carries on its work in co-operation with the University of Alberta. The personnel of the Council at the present time is as follows:

J. E. Brownlee, Premier of Alberta, Chairman.
O. L. McPherson, Minister of Public Works.
R. C. Wallace, President, University of Alberta, Director of Research.
R. S. L. Wilson, Dean, Faculty of Applied Science, University of Alberta.
G. A. Vissac, Esq., Blairmore.
J. I. McFarlane, Esq., Calgary.
R. J. Dinning, Esq., Edmonton.
Secretary, A. E. Cameron, University of Alberta.

TECHNICAL ADVISORS (meeting with Council)

Prof J. A. Allan—Geology.
Prof. N. C. Pitcher—Mining Engineering.
Prof. E. Stansfield—Chemical Engineering.

Requests for information and reports should be addressed to the Secretary, Research Council of Alberta, University of Alberta, Edmonton, Alberta.

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UNIVERSITY OF ALBERTA,

EDMONTON, ALBERTA,

FEBRUARY 14TH, 1930.

HON. J. E. BROWNLEE,
Premier,
Edmonton, Alberta.

SIR:

Under instruction from the Scientific and Industrial Research Council of Alberta, I herewith submit their Tenth Annual Report. This covers the work done under their direction during the year ending December 31st, 1929.

Respectfully submitted,

ALAN E. CAMERON,
Secretary.

TENTH ANNUAL REPORT OF THE SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA

ORGANIZATION

In the organization of the University of Alberta, the staff of the Research Council constitutes the Industrial Research Department, and the Research Council's laboratories are referred to as the Industrial Research laboratories.

In the organization of the Provincial Government the work of the Research Council is attached to the Executive Council.

PERSONNEL AND MEETINGS OF COUNCIL

Two meetings of the Council were held during the year. The personnel of the Council on December 31st was:

J. E. Brownlee, Premier of Alberta, Chairman.
O. L. McPherson, Minister of Public Works.
R. C. Wallace, President, University of Alberta.
R. S. L. Wilson, Dean, Faculty of Applied Science, University of Alberta.
G. A. Vissac, Esq., Blairmore.
J. I. McFarlane, Esq., Calgary.
R. J. Dinning, Esq., Edmonton.
Secretary, A. E. Cameron, University of Alberta.

Technical Advisors (meeting with Council)

Prof. J. A. Allan—Geology.
Prof. N. C. Pitcher—Mining Engineering.
Prof. E. Stansfield—Chemical Engineering.

STAFF

The following changes in the permanent staff have been made during the year:

Resignations—J. L. Reid, April 30th; J. W. Sutherland, August 27th; Kasian Hlynka, December 31st.

Appointments—R. G. Brewer, January 14th; Kasian Hlynka, May 17th; D. S. Pasternack, June 8th; J. L. Doughty, October 1st; H. S. Hicks, October 16th; M. F. Teskey, October 30th.

The permanent staff on December 31st, 1929 was as follows:
Edgar Stansfield, Chief Chemical Engineer;
K. A. Clark, Research Engineer, *Road Materials;*
R. L. Rutherford, Geologist, *Geology;*
W. A. Lang, Engineer, *Fuels;*
D. S. Pasternack, Engineer, *Road Materials;*
K. C. Gilbart, Assistant Engineer, *Fuels;*

R. G. Brewer, Assistant Engineer, *Fuels;*
M. F. Teskey, Fuel Analyst, *Fuels;*
J. L. Doughty, Soils Expert, *Soils Survey;*
H. S. Hicks, Assistant Geologist, *Geology;*
Hazel M. Wortman, Accountant and Stenographer;
Mary Sandin, Geological Stenographer;
Kasian Hlynka, Laboratory Assistant;
Alta Jackson, Office Assistant.

In addition to the above, Professors J. A. Allan and N. C. Pitcher, of the University of Alberta, are in permanent charge of the Council's research work in Geology and Mining Engineering respectively. Professor F. A. Wyatt, of the University of Alberta, is in charge of the Council's work on Soil Surveying. Professor A. E. Cameron acts as secretary to the Council and has charge of the office staff. Also, Dr. R. Procter, Roentgenologist, University Hospital, has made stereoscopic X-ray photographs of coal. Dr. E. H. Boomer, Department of Chemistry of the University, has carried out natural gas and hydrogenation investigations. H. G. Reiber, on the staff of the Industrial Laboratories of the University, has worked part time as a graduate student.

LABORATORIES AND EQUIPMENT

The principal items of laboratory equipment acquired during the year are as follows: Purchased, Gray-King low temperature coal assay apparatus, Kemp and Thompson coal cleaning apparatus, Union gas calorimeter, Casella differential pressure gauge, coking index apparatus, Cox surface combustion gas burner; designed and constructed, duplex gas and air pump, electric furnace for volatile determinations, and flue calorimeter. A general view of the main chemical laboratory is shown in Figure 1.

FUELS

The work of last year was continued, and some new features introduced. Chief among these were cleaning, sample storage, hydrogenation of coal, the action of solvents on coal, and, at the University Hospital, stereoscopic X-ray photography of coal.

The samples received and tested during the year totalled 109. Included in these were 16 channel and 21 other coal samples from the Provincial Mines Branch; 6 coal samples from the Dominion Mines Branch; 32 special coal samples from an Edmonton mine, 15 miscellaneous samples, and 19 coal ash samples from the United States Bureau of Mines.

The tests included many proximate and 5 ultimate analyses, determinations of calorific value, specific gravity, weathering characteristics, ignition temperatures and oxidisability of coal. Many tests were made on two large samples of coal with particular reference to their suitability for washing and briquetting. In addition, fusion temperature of coal ash determinations were made.

A new electric furnace for the determination of volatile matter was designed, constructed, tested and put in regular use. Otherwise the routine methods of last year were continued. The apparatus

Figure 1—Main Chemical Laboratory.

for air drying coal was rebuilt and improved, but the procedure was not changed. A new device has been installed to supply mildly reducing gas for ash fusion tests. Changes have been tentatively made in the potash test for the maturity of coal, but this work is not yet ready for report.

The briquetting investigation was continued, and 72 runs were made. The main work was on bituminous coal with asphalt as binder, but other coals and binders were employed.

The furnace testing equipment had to be dismantled in 1928 for laboratory alterations. This was rebuilt with changes to meet the new conditions. A new flue gas calorimeter and a chamber to temper the cold air were constructed. A gas furnace was submitted by a local inventor; this was tested and a preliminary report made containing suggestions for improvements. A surface combustion gas burner, purchased in England, has been tried but not tested.

Tests have been made on the washability of coals from 6 mines, and graphs prepared summarising the results. A comparative study has been commenced of the clinkering characteristics of raw coal, washed coal, and washery refuse.

A study is in progress on the moisture holding capacity of samples of the lower rank coals, and the effect of time and manner of storage of the samples on the moisture they retain after standard air drying.

Hydrogenation tests have been made under the direction of Dr. Boomer on several samples of coal. In addition, six typical samples were sent to Professor Ivon Graham for hydrogenation tests at the University of Birmingham, England, but no report has yet been received.

Dr. R. Procter, Roentgenologist at the University Hospital, made X-ray photographs of a number of lumps of typical coals supplied for the purpose. These photographs were arranged to be viewed stereoscopically, and showed clearly the distribution of mineral impurities in the coal.

Methods have been developed for testing the solubility of coal in different organic solvents, and a number of coals tested. This work is being done by a graduate student for his M.Sc. thesis.

GEOLOGY

The work of the Geological Survey Division of the Council is carried on in conjunction with the Department of Geology at the University of Alberta, under the direction of J. A. Allan. The palaeontological material obtained on field surveys is determined by P. S. Warren, and in return for this co-operation, R. L. Rutherford assists in teaching in the Department of Geology. Since the close of the field season, H. S. Hicks has been conducting a laboratory investigation of the rock specimens collected in the course of a survey of the Precambrian rocks in Lake Athabaska area conducted during the past summer by A. E. Cameron.

No separate geological report has been published during the year, but three summary reports were given in report No. 24. These were: Jasper Park Area by J. A. Allan; and preliminary

notes on the geology of the Peace Hills area and on the Athabaska and Lesser Slave lake districts, by R. L. Rutherford.

Four field parties carried on geological investigations for varying periods during the season. These were as follows: One party, under the direction of R. L. Rutherford, commenced a field survey of an area along the Peace river and Smoky river. The object of this survey was to obtain geological information relative to the water supply in those districts where the water problem is most acute, namely, in the Falher, Spirit River and Waterhole districts. One party, under the direction of A. E. Cameron, began field investigations on the Precambrian area in the northeast corner of Alberta north of Lake Athabaska and east of Slave river. A third party continued the survey in Jasper Park. About a week was spent in the Snake Indian Valley district investigating a reported deposit of gypsum. A few days were spent continuing the Athabaska section west of the foothills. The survey in the inner foothills between the Bow valley and the North Saskatchewan river was continued, and L. S. Russel spent about two and one-half months in the field. The object of this survey is to obtain accurate data on the relation between the Edmonton and Paskapoo formations. This is important information for geological investigations over a large part of Alberta.

Additional geological data were obtained by J. A. Allan and by R. L. Rutherford, chiefly along the valleys of the Bow, Red Deer and Little Red Deer rivers and Pekisko creek. Water supply data, additional to that from the Peace River district, were obtained in the districts of Wetaskiwin, Lacombe, Olds and Magrath.

An appendix to this report gives the scope of the work carried out by the Geological Survey Division during the year 1929.

ROAD MATERIALS

The Road Materials Division have commenced an intensive two year programme of the bituminous sand investigations with special reference to commercial applications. An important development in the general problem of bituminous sands work occurred early in the year when an agreement was reached with the Department of Mines, Ottawa, for co-ordination of the efforts of this latter body and ourselves. In essence, this agreement permits the Research Council to devote its energies almost entirely to commercializing our separation process. A copy of the agreement is given later.

A new laboratory model plant was erected early in the year and preliminary experiments conducted. As soon as the season permitted, the separation plant at Dunvegan Yards was remodelled and about one carload of bituminous sand separated. This plant was then dismantled and re-erected near the Department of Mines quarry close to Waterways, Alberta. Trial runs on this plant were conducted the latter part of October and the plant proved satisfactory. This successful conclusion of the season's operations was a matter of considerable satisfaction, as it is felt that this marks a very great advance toward the commercializing of the bituminous sands.

Report on the laboratory investigations and the construction and operation features of the semi-commercial plants, both at the old one at Dunvegan Yards and the new one at Waterways, are discussed in more detail in an appendix to this report.

SOIL SURVEYS

At the request of the Provincial Government the Research Council during 1929 undertook the general supervision of extensive soil surveys in the northern portions of the Province. Three field survey parties were in the field for the greater part of the field season. The work was directed for the Council by Dr. F. A. Wyatt, Professor of Soils at the University of Alberta. J. L. Doughty was in charge of a field party in the area north and west of Athabaska. A. Leahey had charge of the field party in the area between Grimshaw and Keg River. O. R. Younge had charge of the field party in the area between Dunvegan and the British Columbia-Alberta boundary.

Preliminary reports covering the results of these field surveys appear in the appendix to this report.

CHEMICAL UTILIZATION OF NATURAL GAS

The investigations of the Alberta natural gas, commenced during 1928, have been continued throughout 1929. This work has been undertaken for the Council by Dr. E. H. Boomer, Assistant Professor of Chemistry at the University of Alberta. The National Research Council of Canada co-operates with this work and carries a portion of the cost of the investigations.

Progress report on this work, prepared by Dr. Boomer, appears in the appendix to this report.

MISCELLANEOUS

February 11th a conference with the Coal Operators of the Province was held in Edmonton to discuss the programme of research for the year. On October 12th a conference with representatives of the Dominion Department of Mines was held in Edmonton to discuss the co-ordination of fuel investigations in Edmonton and Ottawa. As a result of this meeting a co-ordinating committee was later appointed consisting of J. McLeish and R. E. Gilmore representing the Dominion, and R. C. Wallace and E. Stansfield representing Alberta.

In March J. A. Allan and A. E. Cameron attended the annual meeting of the Canadian Institute of Mining and Metallurgy, in Winnipeg.

In the latter part of March A. E. Cameron spent about two weeks in Ottawa on matters pertaining to surveys in Northern Alberta, both the projected soil surveys and the survey of the Precambrian area. At that time he consulted with Hon. Mr. Charles Stewart, Minister of Mines, Dr. Charles Camsell, Deputy Minister of Mines, Dr. H. M. Tory, President of the National Research Council, and various officials of the Mines Branch, on

matters pertaining to the bituminous sands investigations, and it was largely as a result of these conferences that the co-ordinating agreement between the Department of Mines at Ottawa and the Research Council was later developed.

J. A. Allan, E. Stansfield and J. W. Sutherland attended a meeting of the Canadian committee on coal classification (National Research Council) held in Edmonton October 8th.

E. Stansfield represented the National Research Council at a meeting of the United States committee on coal classification, held at Philadelphia November 21st and 22nd. He later spent several days in Ottawa with officials of the National Research Council and the Department of Mines, and visited the new Fuel Testing Station. He also visited the lignite carbonizing and briquetting plant of the Western Dominion Collieries, near Bienfait, Saskatchewan. W. A. Lang spent a week at this lignite plant, in December, and a day at the briquetting plant of the Canmore Coal Company, Canmore, Alberta, studying the commercial aspects of carbonizing and briquetting.

During the year radio talks on technical subjects were broadcast by J. A. Allan, R. L. Rutherford, K. A. Clark and A. E. Cameron, from the University station, CKUA.

ACKNOWLEDGMENTS

Appreciation is expressed to the following for assistance given and courtesies rendered during the year: Dr. R. Procter, Roentgenologist, University of Alberta, Edmonton; R. M. Young, General Manager, The Canmore Coal Company, Canmore, Alberta; C. G. Ashwin, Managing Director, Western Dominion Collieries, Winnipeg, Manitoba, and to resident officials of the same company at Taylorton. Thanks are also due to the Northwestern Utilities, Ltd., Edmonton, for loan of gas meter, and to the Coal Operators of the Province for coal samples supplied by request.

The department also wishes to express its appreciation of the very real way in which the Mines Branch, Department of Mines, officials have entered into the spirit of the co-ordinating agreement with respect to bituminous sands. Special mention should be made of the assistance rendered by Mr. S. C. Ells and his party at Waterways in the clearing of the site for the new plant, and in the transportation of materials and supplies from Waterways to the job. The new plant at Waterways has been constructed on land under the control of the Department of Mines.

PUBLICATIONS DURING 1929

Report No. 18, The Bituminous Sands of Alberta, Part III, Utilization, by K. A. Clark.

Report No. 24, Annual Report of Council covering the work done in 1928.

"Alberta Coals—Analyses and Tests." Private report to the Coal Operators, February, 1929.

"Laboratory Investigations of the Coking Properties of Alberta Coals." Private report to the Bituminous Coal Operators, February, 1929.

"News Letter to Coal Operators of Province," April, June and October, 1929.

"Salt and Gypsum in Alberta," by J. A. Allan, Trans. Can. Inst. Min. & Met., 1929.

"The Classification of Canadian Coals," by E. Stansfield and J. W. Sutherland, Trans. Can. Inst. Min. & Met., 1929.

"The Separation of the Bitumen from Alberta Bituminous Sands," by K. A. Clark, Trans. Can. Inst. Min. & Met., 1929.

"Precambrian Algal Structures from the Northwest Territories," by R. L. Rutherford, Amer. Jour. Sci., Vol. XVII, March, 1929.

"Sedimentary Record in the Rocky Mountains at about the 51st Parallel," by P. S. Warren, Can. Field Naturalist, Vol. 43, No. 2, February, 1929.

FUELS DIVISIONS

By E. Stansfield, W. A. Lang, J. W. Sutherland, K. C. Gilbart, R. G. Brewer and M. F. Teskey.

W. A. Lang continued the briquetting investigation. He also made determinations of the specific gravity of coal and of fusibility of coal ash, and he assisted with determinations of calorific value. J. W. Sutherland acted as fuel analyst until his resignation. He studied the applicability of many schemes of coal classification to Canadian coals, an amplification of his earlier work on Alberta coals. K. C. Gilbart continued furnace testing, the determination of the decomposition and softening temperatures of coking bituminous coals and also work on the maturity of coal. R. G. Brewer carried on studies on the washability of coal by heavy solutions, began work on the moisture retaining property of coal in relation to various methods of storage, and assisted with fusion of ash determinations. M. F. Teskey took over the duties of fuel analyst in November. He also assisted with several of the above investigations.

Coals Tested

Provincial Mine Inspectors submitted 37 coal samples, 16 regular channel samples for analysis and 21 samples for special investigation. Coal Operators submitted 9 samples, ranging from 50 lbs. up to one ton in weight; the Dominion Mines Branch sent 6 coal samples for comparison analyses; the United States Bureau of Mines sent 19 coal ash samples for comparison test; and 6 miscellaneous samples were also received. In addition, 32 coal samples were collected from a local mine. Samples were received during the year from 6 mines not previously sampled, and samples from 294 mines have now been analysed.

Sampling and Analysis

No real change has been made during the year in the regular method of sampling and analysis, although a new electric furnace is now used for the determination of volatile matter. This was designed and constructed in these laboratories. It is a modification of the Fieldner Furnace, but the opening is at the bottom instead of the top; also the heating chamber is considerably larger. The platinum crucible rests on a platinum triangle, with rigid alundum supports. These supports are fixed to an asbestos plate which slides up and down below the furnace in guides which also act as legs for the furnace. When the crucible is in position in the furnace the plate is held by two clips. There is a hole in the centre of the asbestos plate, and the bottom of the furnace is always open.

The opening was designed at the bottom of the furnace to cut down convection currents of hot air. This inversion of the furnace

also caused the initial heating of the crucible to be from the top downwards, which reduces the tendency to spark with sub-bituminous and lignitic coals. Such coals, however, are always given an initial preheat, as described in the Third and Fourth Annual Reports.

The size of the heating chamber makes it easy to maintain a uniform temperature. This can be kept within ±10° of the required 950°C with only rheostat control. The thermocouple wires are led in through the top in a thin walled, sealed, silica tube which terminates about half an inch above the crucible lid. The

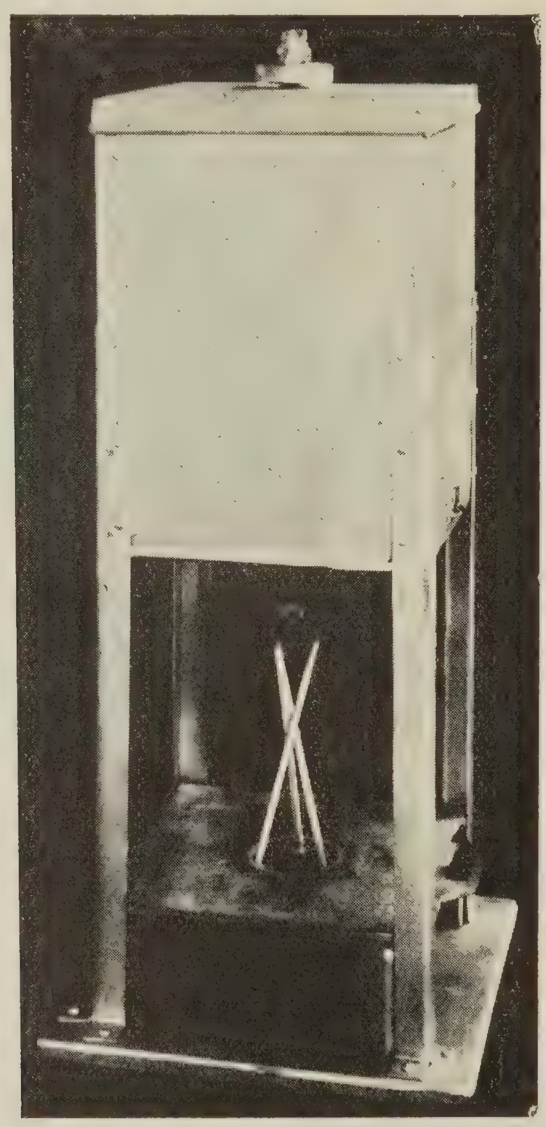


Figure 2—Volatile Matter Furnace.

thermocouple junction is shielded from the cooler cover by means of an alundum screen. Figure 2 is a photograph of this furnace, with the crucible support lowered.

The standard air-drying apparatus described in the Fourth, Sixth and Seventh Annual Reports has been rebuilt and improved. The improvements are mainly in compactness and in precautions against leaks and damage. No change in principle is involved. Figure 3 shows the apparatus as rebuilt.

Chemical Survey of Alberta Coals

This work has progressed steadily but no special report is necessary this year. A private report summarising the results of the work of recent years was sent to the Coal Operators in February.

Air Drying of Coal Samples

Work is in progress on the moisture holding capacity of the lower rank coals. It is found that the moisture retained after standard air drying reflects to a notable extent the past history of the sample. Thus a sample that has been stored, particularly if exposed to air, will always retain less moisture after air drying than will a fresh sample of the same coal. It was thought that it might be possible to bring the sample back nearer to the original condition by soaking it in water, and then centrifuging, before air drying; but this was not found to be the case. At present it appears that a sample can be stored in a hermetically sealed container for 2 or 3 weeks without notable change, but that for longer storage the sample should be kept under water.

Slacking Characteristics of Coal

Only seven samples of coal were received for weathering tests. The results obtained were in accordance with previous results reported in the Ninth Annual Report, No. 24, 1928, Page 16.

Fractionation Studies of Coal

Work has been in progress for several years on a method of studying characteristics of coal by means of fractionation of the samples by means of heavy solutions. This method is employed to prepare a graphic representation of the relation between the calorific value and ash yield of a coal, and between the mineral matter content and ash yield. The method is also used in studies of the oxidisability of coal. This work has been referred to in earlier Annual Reports, but a full description has now been prepared and will be presented to the American Institute of Mining and Metallurgical Engineers, at the New York meeting, February, 1930.

Specific Gravity of Coal

Determinations of the apparent specific gravity were made on 78 samples from 7 different mines. Charts have been prepared for most of the coal areas—showing the variation in cubic feet per short ton of the coal in place in the seam with the ash yield of the coal. More data must be obtained before these charts are fully established.

Fusibility of Coal Ash

The modified A.S.T.M. method described in the Ninth Annual Report, p. 17, has been further improved by the addition of a power driven, duplex air and gas pump. This pump supplies a suitably proportioned mixture of air and gas to the inner crucible

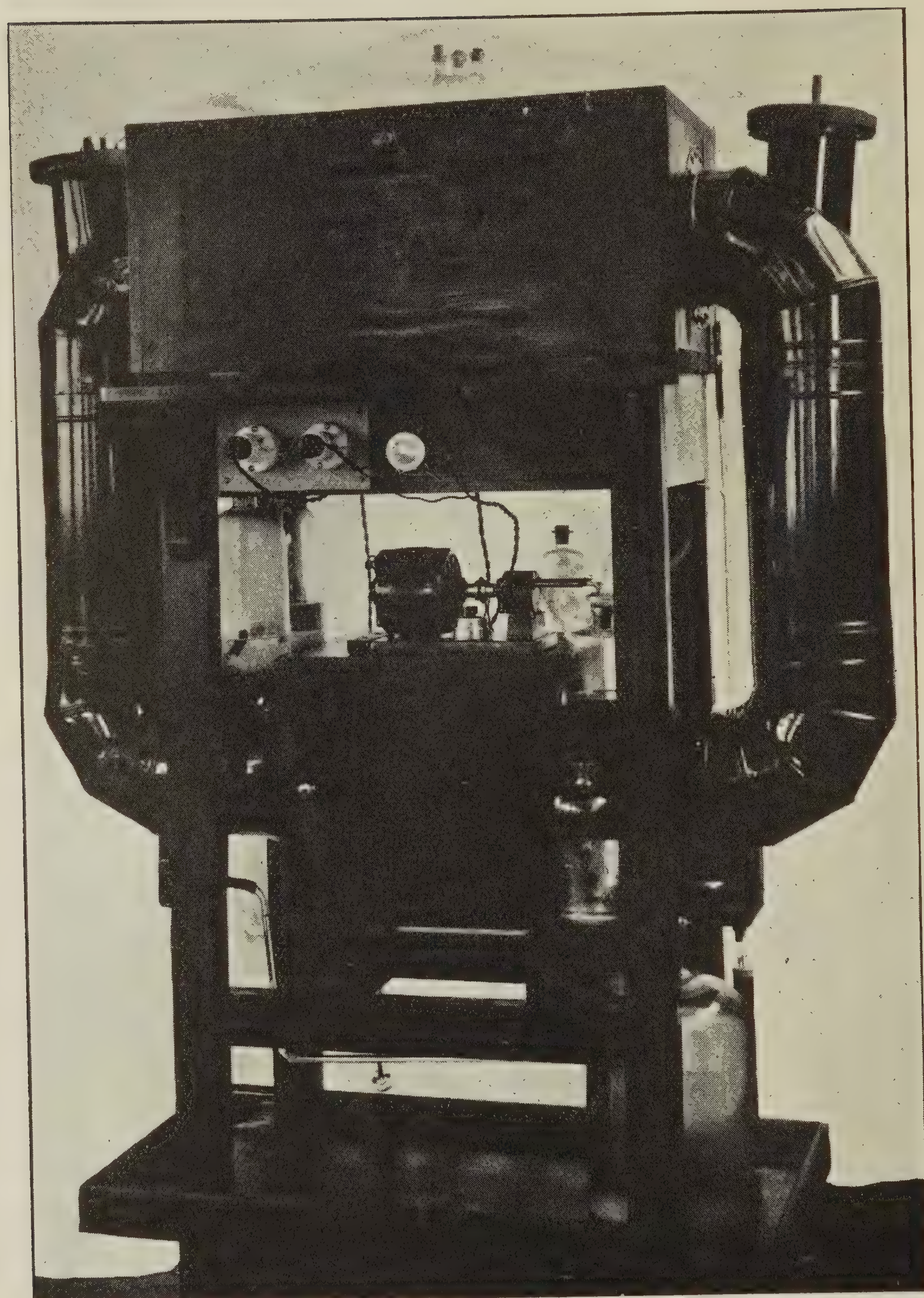


Figure 3—Air Drying Apparatus.

in which the ash cones are heated, and this ensures there the requisite mildly reducing atmosphere, throughout the test, and irrespective of the adjustment of the gas burner of the furnace. Calculation shows that one volume of Viking natural gas burned with three volumes of air gives a mildly reducing product containing about 50% of reducing gases.

The duplex pump was designed as a simple method for supplying air and gas in the desired proportions; its construction is shown in Figure 4.

Many tests were made with the De Graaf Fusion of Coal Ash Apparatus in an effort to correlate its results with those obtained by the standard method. Co-operative tests were also made on this apparatus with 19 samples supplied by United States Bureau of Mines. It was not found possible to get satisfactory tests with this apparatus, and its use here has been abandoned.

The above mentioned 19 samples were also tested in the modified A.S.T.M. method referred to above, and reasonable agreement found with the results reported later from Pittsburgh.

Coal Cleaning

Tests have been carried out on six Alberta coals to indicate their amenability to cleaning by commercial processes. This work is still in progress.

The tests made include first a screen analysis of the coal supplied and then separation of each size of coal into fractions respectively floating and sinking on liquids or solutions of different specific gravity.

A special laboratory apparatus designed by Kemp and Thompson was used for making these tests on the larger sizes. This equipment consists of a cylindrical container with a rectangular trough about four inches deep attached to the side at the top. Inside this outer container is a closely-fitting vessel having a sieve at the base. A side of this inner vessel is cut away four inches from the top so that a scoop with a flat sieve base is free to move along the trough and fit evenly into its side. The vessel may be jigged up and down and removed by means of a pair of handles fastened at the top. A distribution box with six valves and a system of tubes connects the outer container with six solution bottles placed under the table on which the apparatus is mounted. When air pressure is applied to the interior of the bottles and the valve in the pipe leading to any one of the bottles is opened, the liquid in that bottle rises into the container at the top and used for a separation. The liquid then can be run back into the bottle and can be used again. Calcium chloride solutions of 1.32, 1.36, 1.42 specific gravity are used, and calcium nitrate solutions of 1.48, 1.52, and 1.55.

The scoop is placed in the trough, and the inner container turned so that it blocks the entrance to the trough. The coal to be tested is placed inside the container and solution of the desired specific gravity forced in as described. The separation of the sample into float and sink is aided by first jigging the container up and down, but is completed by allowing to stand. The con-

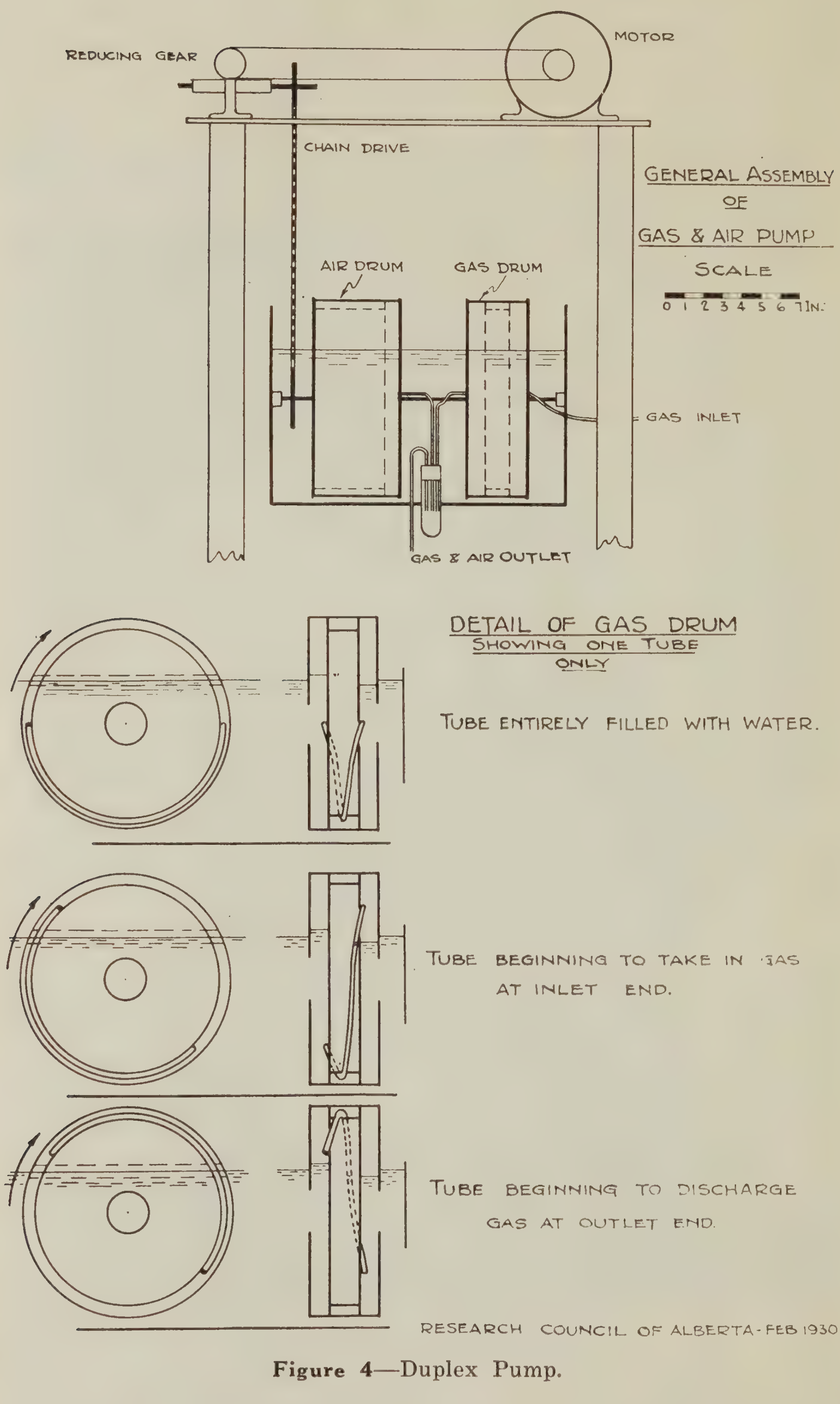
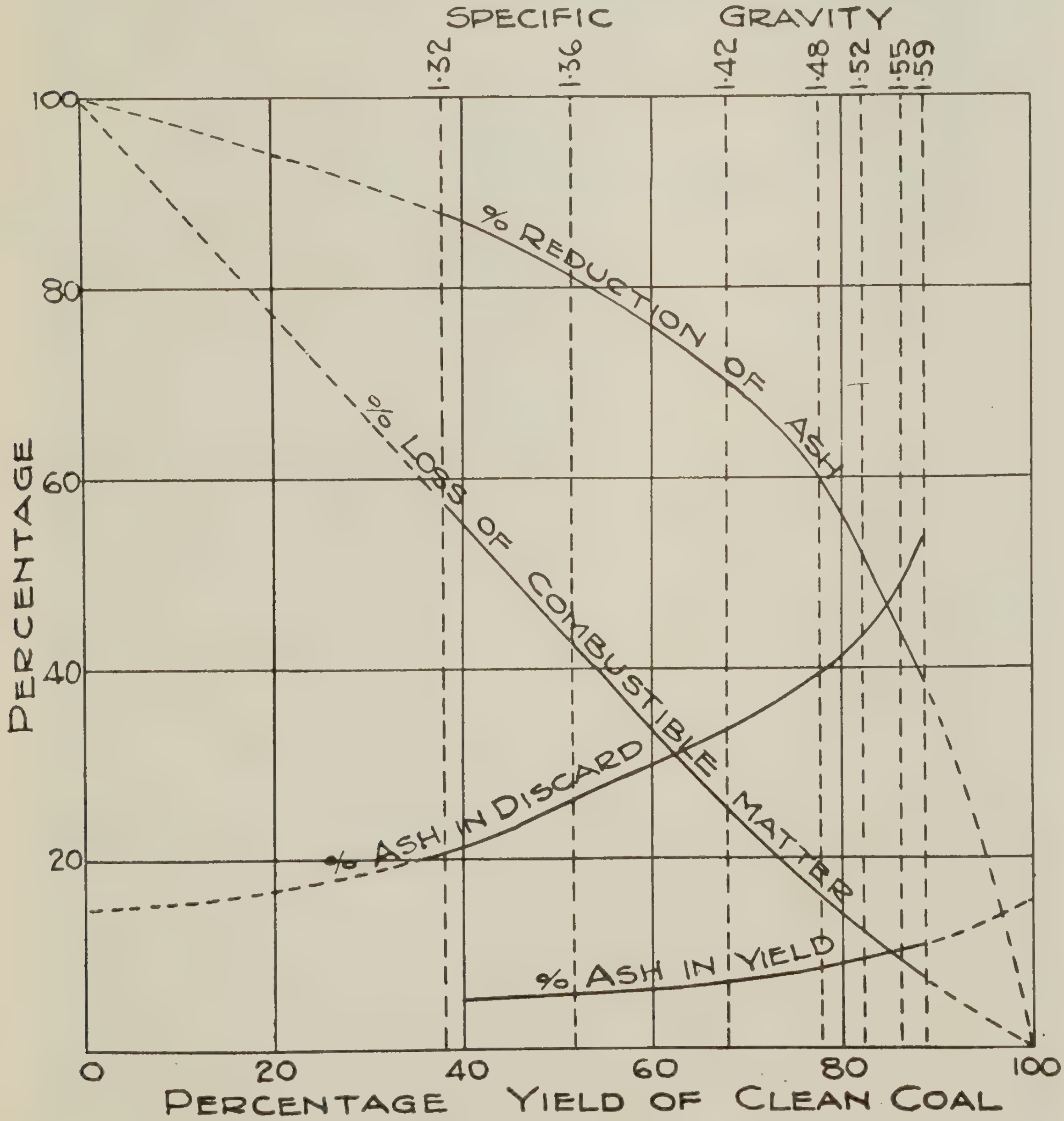


Figure 4—Duplex Pump.

tainer is then turned around to allow the scoop to be moved in and thus collect the float. The solution is drained off, the float and sink removed in their separate compartments in the container, washed free from solution, dried, weighed, and analysed for ash. The apparatus is not suitable for use with fine coal. The fines are separated in this laboratory by centrifuging in special cups. The heavy liquids employed are mixtures of carbon tetrachloride and benzene.

Mixtures of carbon tetrachloride and bromoform are used when higher gravities are required than those mentioned above.

The type of information obtainable is shown in the accompanying graph. Thus graph 1 shows that when the yield of cleaned coal is 80% of the raw coal treated, the ash in the clean coal is 8.5%, the ash in the sink or material discarded is 41%, the loss of combustible matter in the discard is 13.8%, and that 55.1% of the original ash is removed in the discard.



GRAPH I

The vertical dotted lines correlate the specific gravities of the solutions employed with the values indicated in the curves. The graph shown gives composite curves for a run-of-mine bituminous coal.

BRIQUETTING.

The work of briquetting was largely confined to samples of coal received from two bituminous mines. Reports of this work have been given to the Operators concerned.

During the year 73 runs of briquettes were made—22 with bituminous coal, 6 with sub-bituminous coal, and 5 with carbonized lignite. Of these 43 batches were made with asphalt binder, 5 with an asphalt emulsion, 14 with soft coal tar pitch, 2 with hard coal tar pitch, and 9 with miscellaneous binders.

The results obtained in these runs confirm previous results with respect to the importance of controlling the sizing of the coal used for briquetting, of controlling the temperatures of mixing and pressing and, also, of the effects obtained by the addition of moisture in briquetting.

Briquettes made using an emulsified asphalt as binder have not been as satisfactory as briquettes made under similar conditions with the same percentage of asphalt, calculated as dry asphalt in both cases. The briquettes with emulsified binder gave a higher loss when tested in the rattler; they also showed a considerable absorption in water. Insufficient runs have been made, however, to arrive at definite conclusions, as the best conditions for briquetting with emulsified binders may not yet have been discovered.

FURNACE TESTING

The warm air furnace testing equipment had to be dismantled in 1928 on account of laboratory alteration. This was redesigned and rebuilt to fit into a one storey room. The warm air calorimeter was suspended from the ceiling, and arranged so that any furnace to be tested can be connected to it with the minimum of trouble. The warm air mixing device is now part of the calorimeter.

The old flue gas calorimeter embodied the principle of determining the drop in temperature of the gases when a measured amount of heat was taken up by a weighed flow of water. This could not be used with the flue gases from a natural gas furnace because the high moisture content of these gases resulted in the condensation of water on the cooling coils. A new calorimeter was therefore built in which the gases are heated rather than cooled. A measured quantity of electricity is passed through a heating coil, and the resulting rise in the temperature of the flue gases is determined. Even with this arrangement there is a possibility of error if the flue gases entering the calorimeter contain particles of condensed water (mist). For such conditions a preheater is provided. The flue gas temperature is measured before the gases enter the preheater, but the calorimeter measurements are all made on dry gas, i.e., above the dew point.

A cooling tower has been provided to temper the air supplied to the cold air inlet of the furnace tested. Additional equipment included a Casella differential pressure gauge attached to a multiway, mercury sealed, connecter and arranged so that the pressures between various points could be rapidly read on the one instrument.

Figure 5 is a photograph of the present equipment attached to a gas furnace. Figure 6 is a diagrammatic sketch of the flue gas calorimeter.

A gas furnace designed and patented by Dr. A. O. Sproule, Edmonton, was submitted for test. This furnace was used incidentally in testing the suitability of the present warm air furnace testing equipment for such work.

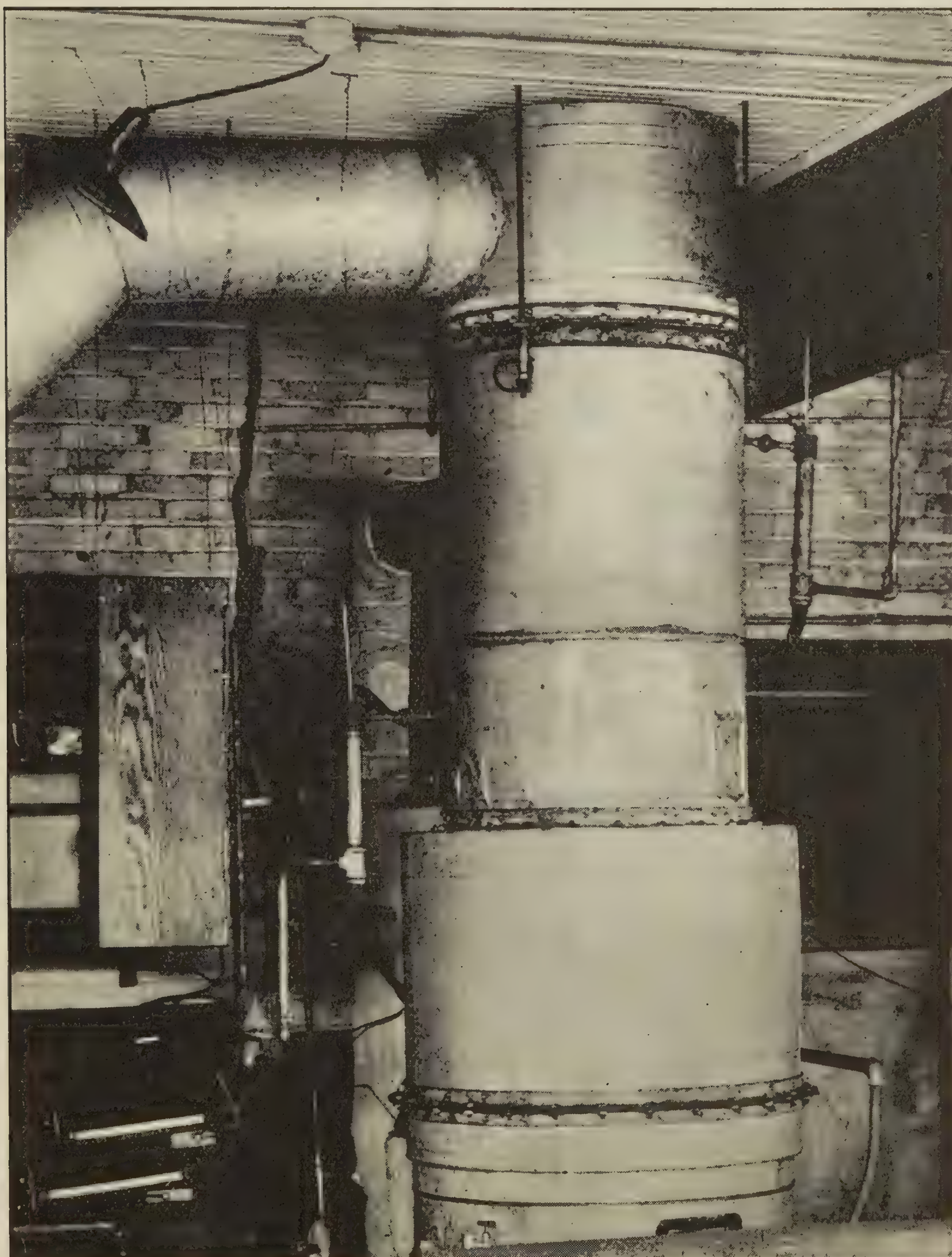


Figure 5.

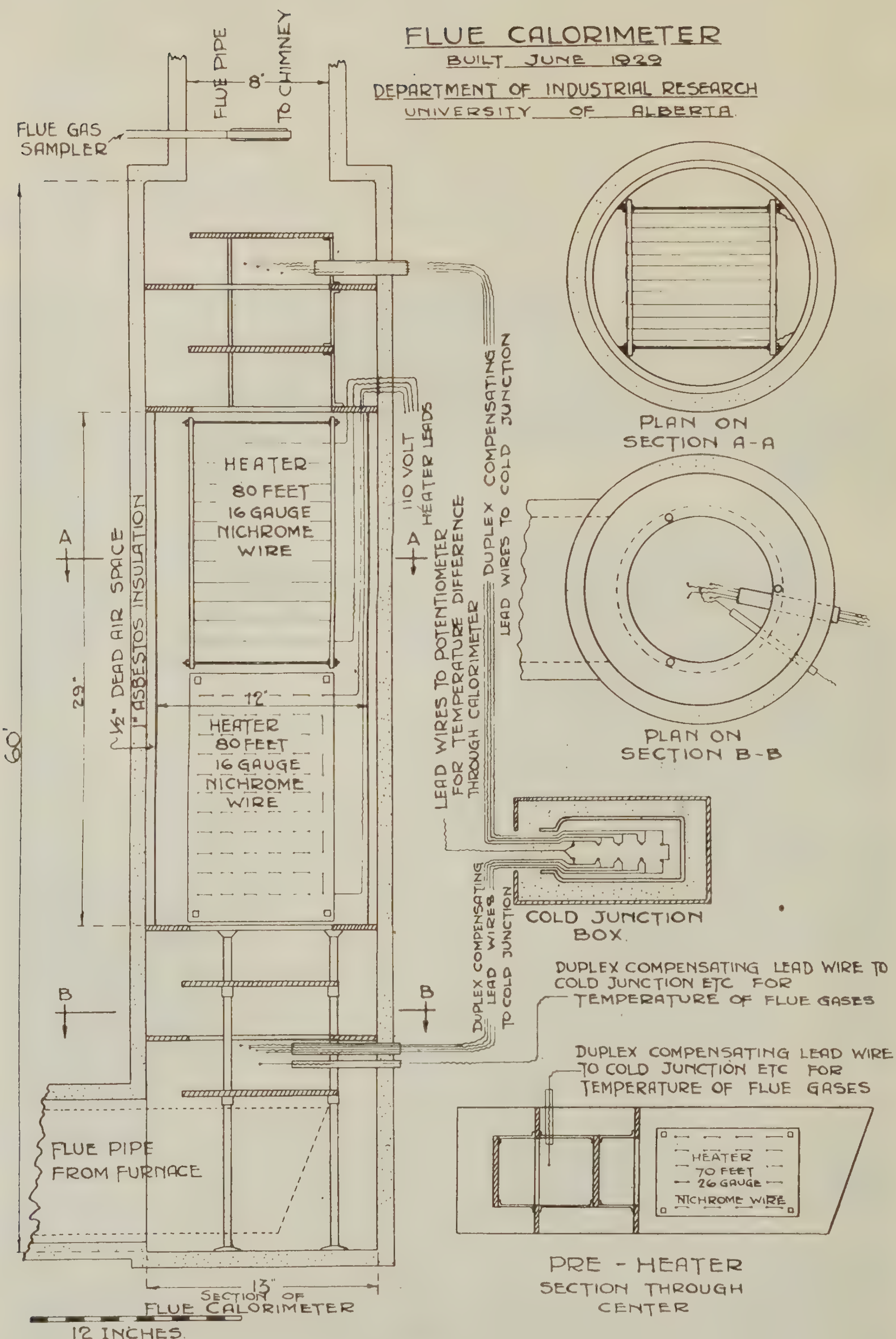


Figure 6—Calorimeter.

GEOLOGICAL SURVEY DIVISION

REPORT OF PROGRESS, 1929

By John A. Allan

Introduction

Office details, including compilation of field data, correspondence and preparation of information requested, has taken an increased amount of time during the year. The office was kept open throughout the year, with the exception of two months during the summer. Efficient secretarial assistance was obtained from Mrs. M. Sandin.

R. L. Rutherford, geologist, was associated with the writer in the various survey duties in the office and in addition gave instruction in the Department of Geology. He compiled a geological map of the Peace Hills sheet and prepared a report from his notes on the observations made in the field. This report and map will be published at a later date when additional geological information has been obtained at a few localities within this area.

Correspondence relating to this Division amounted to approximately 750 letters received and sent out. The information requested was of the usual variety on the mineral and water resources of the Province. The interest in water supply today is evident from the increasing number of requests made for information on this subject. An important part of the correspondence dealt with reports already published by this Division. Several hundred copies of back numbers were distributed throughout the year, including a number of sets, in so far as they are available for distribution, to libraries, universities and other institutions. Geological reports numbers 6, 7 and 9 are now out of print and are no longer available for distribution. Specimens of minerals, rocks, ores, fossils and clays were received. These were examined and the parties concerned informed of the results. The samples requiring chemical analysis were forwarded to Mr. J. A. Kelso, Director of the Industrial Laboratories, University of Alberta.

Drafting work related to this Division has increased considerably. Not having a regular draftsman, the necessary assistance in the drafting room was obtained for short periods from G. A. Harcourt, J. F. Caley, G. Runge and N. Melnyk. A glass-topped tracing table has been added to the equipment in the drafting room.

Since the close of the field season, H. S. Hicks has been conducting a laboratory investigation of the rock specimens collected during a survey of the Precambrian rocks in Lake Athabaska area conducted during the past summer by A. E. Cameron.

Fossil material collected by our men in the field or sent in by other parties from various parts of Alberta were examined, deter-

mined and classified by P. S. Warren, Associate Professor of Geology at the University of Alberta. These services, so generously given, the writer wishes to acknowledge with thanks. This phase of the work increased during the year because large collections were received through the kindness of the Hudson's Bay-Marland Oil Company, now the Hudson's Bay Oil and Gas Company. Our thanks and appreciation for these fossil collections are extended to the members of this Company, and particularly to Messrs. Powers and Webb, and to Mr. Hake when with this Company. The collection and correct determination of fossils are of the greatest importance to the working out of the distribution of the various geological formations. Close attention is given in the field to the discovery and collection of fossils from the strata being investigated.

The fossil material, as well as the mineral and rock specimens collected in the field surveys, have been added to the collections in the Department of Geology at the University of Alberta. One specimen case has been added during the year for storing of this material, but additional space is required and additional cases will have to be obtained.

Four field parties carried on geological investigations for varying periods during the season. These were as follows:

One party, under the direction of R. L. Rutherford, commenced a field survey of an area along the Peace river and Smoky river. The object of this survey was to obtain geological information relative to the water supply in those districts where the water problem is most acute, namely, in the Fahler, Spirit River and Waterhole districts. Additional notes on the results of this work are given below.

One party, under the direction of A. E. Cameron, began field investigations on the Precambrian area in the northeast corner of Alberta north of Lake Athabaska and east of Slave river. Additional notes are given below on the results obtained.

A third party continued the survey in Jasper Park. About a week was spent in the Snake Indian Valley district investigating a reported deposit of gypsum. A few days were spent continuing the Athabaska section west of the foothills. Additional notes on this field are given below.

The survey in the inner foothills between the Bow valley and the North Saskatchewan river was continued, and Mr. L. S. Russell spent about two and one-half months in the field. The object of this survey is to obtain accurate data on the relation between the Edmonton and Paskapoo formations. This is important information for geological investigations over a large part of Alberta.

Additional geological data were obtained by the writer and by Rutherford, chiefly along the valleys of the Bow, Red Deer and Little Red Deer rivers and Pekisko creek. Water supply data, additional to that from the Peace River district, were obtained in the districts of Wetaskiwin, Lacombe, Olds and Magrath.

A report of progress of the various phases of the work in the Division during 1928 was prepared. This report and an outline

map showing the Edmonton-Paskapoo boundary between Edmonton and Ponoka, appearing as Plate IX, are included in the Ninth Annual Report, No. 24, of the Scientific and Industrial Research Council of Alberta.

Some time was spent preparing the text for report No. 13 on the Red Deer and Rosebud sheets. This joint report with J .O. G. Sanderson is now almost ready for publication and will be issued within a few months.

Revisions of the Coal Areas Map of Alberta and also the Geological Map of Alberta have become necessary, and data related to this revision have been compiled.

During the summer, conferences were held in Calgary with Dr. R. T. Elworthy in connection with the natural gas investigation undertaken by the Alberta Waste Gas Commission, and also with Professor W. G. Worcester regarding a ceramic survey under the auspices of the Federal Department of Mines relative to the possible use of surplus natural gas in the Turner Valley field.

The Annual Meeting of the Canadian Institute of Mining and Metallurgy was attended in Winnipeg in March, and a paper was presented by the writer on "Salt and Gypsum in Alberta."

The value of aerial photographs in carrying on geological survey and soil survey work has become more apparent each year. Early in the year A. E. Cameron had a conference in Ottawa on the plan of aerial surveys to be contemplated in the near future and the aerial photographs already taken within Alberta. Arrangements have been made with the Federal Government whereby copies of all aerial photographs taken in Alberta will be stored in Edmonton. Up to the present time about 8,000 aerial photographs have been received, out of an order of about 25,000. These are being catalogued and kept for future use in metal cases and are stored in the Department of Geology at the University of Alberta. Acknowledgment is also made of index maps, prepared by the Topographical Survey of Canada, showing the position of all these aerial photographs.

When in Eastern Canada during the summer the writer had a conference in Ottawa with the Surveyor General and other officials of the Topographical Survey of Canada relative to aerial surveys in Alberta and other survey data.

Publications from the Division in 1929

Progress Reports in Geological Survey Division in Report No. 24, Ninth Annual Report, Scientific and Industrial Research Council of Alberta:

1. Summary of Investigations in 1928, by J. A. Allan.
2. Jasper Park District, by J. A. Allan.
3. Preliminary Notes on the Geology of the Peace Hills Area, with map, by R. L. Rutherford.
4. Athabaska and Lesser Slave Lake Districts, by R. L. Rutherford.

"Salt and Gypsum in Alberta," by J. A. Allan, Trans. Can. Inst. Min. & Met., 1929.

"Alberta's Mineral Value Ranks Fourth in Canada," by J. A. Allan, Monetary Times, Vol. 84, p. 232, 1930.

"Precambrian Algal Structures from the Northwest Territories," by R. L. Rutherford, Amer. Jour. Sci., Vol. XVII, March, 1929.

"Sedimentary Record in the Rocky Mountains at about the 51st Parallel," by P. S. Warren, Can. Field Naturalist, Vol. 43, No. 2, Feb., 1929.

PUBLICATIONS RECEIVED IN 1929

Memoirs and maps have been received and are acknowledged from H.M. Geological Survey, England; reports and bulletins have been received from the Mineral Resources Department, Imperial Institute, London; from Gold Coast Geological Survey; and from Federal, Provincial and State Geological Surveys, Departments of Mines, several universities and other government and scientific institutions.

FIELD INVESTIGATIONS

1. *Peace River Water Supply Survey.* There are certain parts of Alberta where the lack of water supply for domestic purposes is a hindrance to the development of that district. Such conditions exist in certain parts of the Peace River country. As the supply of underground water is directly connected with the distribution of the underlying rock formation, a geological survey was commenced in part of the Peace River country last summer. This party was under the direction of R. L. Rutherford who commenced a field survey of a triangular area from McLennan west to Spirit River and north of the Peace River valley to Waterhole, comprising about 1230 square miles. The object of this survey was to obtain geological information relative to the possible water supply in those districts where the water problem is most acute, namely, Falher, Spirit River and Waterhole districts.

Quite definite results were obtained; most of these were of a negative character, indicating that supplies of good water are rather problematical. No definite assurance can yet be given that there is a water supply, but Rutherford has determined that there are rocks suitable as water reservoirs under these districts. The depth from the surface will vary with the locality, but in general the depths as determined from this preliminary survey will vary from about 350 feet in the Fairview district, to about 700 feet in the Falher district and in other areas to the south of the Peace. The water resources in this shallowest reservoir bed can only be determined by drilling at particular localities. Rutherford's results warrant a drilling program being undertaken, and in any wells drilled utmost care must be taken to have all the surface water, high in dissolved salts, shut off, before lower beds are drilled into. The drilling tests made to date by private interests have not determined the water possibilities in this part of Alberta. This survey will be continued in the current year.

R. L. Rutherford has prepared the following preliminary report on his field investigations.

Report of Progress on the Water Supply in the Peace River Country

By R. L. Rutherford

During the months of June, July, August and part of September, a field examination was made in certain districts of the Peace River country, for the purpose of obtaining data relative to the possibility of obtaining an adequate supply of water suitable for domestic purposes. In most of these districts the present water supply is obtained from accumulations of seasonal precipitation. Dry years, accompanied by increased agricultural development, have tended to deplete this supply to a marked degree, and boring for a supply of ground water has become necessary.

The field work carried out consisted of examining the strata which underly these areas, and collecting data on wells that have been drilled, dug, or bored at many places.

The underlying strata are exposed along the Peace and Smoky rivers. The exposures along these streams were examined at many places to determine the stratigraphical succession and to ascertain the nature and position of possible water horizons.

The following districts and their approximate dimensions are those most in need of a supply of water:

1. Falher district—24 miles east to west, by 20 miles north to south .... 480 sq. mi.
2. Spirit River—45 miles east to west, by 10 miles north to south .... 450 sq. mi.

New settlement to the east and west will very likely have similar water conditions. This will increase the Spirit River district to about 100 miles long and an average of 20 miles wide.

3. Waterhole district—25 miles east to west, by 12 miles north to south .... 300 sq. mi.

This district will be increased in size as new settlement proceeds to the west.

These districts are underlain by a series of marine shales known as the *Smoky River shales.* Water does not penetrate these beds readily, and any that does collects a relatively high percentage of salts from the shales, thus rendering the water extremely hard and unsuitable for domestic purposes. There are some thin sandstone beds in these shales, but these are not suitable as water horizons.

The Smoky shales overly a series of deposits known as the *Dunvegan formation.* This formation is approximately 450 feet thick and contains several thick sandstone beds interbedded with shale. These sandstones in the formation are considered as possible water horizons underlying the districts referred to above.

The strata in these districts have a gentle dip to the south and consequently the Dunvegan formation, which outcrops along Peace river at Dunvegan ferry, rises to the north from the river and lowers to the south. Thus drilling depths to this formation will vary, being shallower on the north side of the Peace than on the south. In general the depths to this formation from the surface

is from 350 to 400 feet in the Waterhole district, to 650 to 700 feet in the Falher and Spirit River districts.

The Dunvegan formation where exposed does not give evidence of carrying any appreciable supply of water. These exposures, however, are in most cases somewhat removed from the districts referred to.

Recent drilling in the Falher district to depths of 600 to 700 feet has given a supply of water at McLennan. This supply, while apparently of sufficient quantity, is rather high in dissolved salts and insoluble mineral matter, the latter making the water quite muddy when pumped. Tests have been made at Falher to a depth of 608 feet with unsatisfactory results.

Several tests have been made within the last few years in the Waterhole district. The most satisfactory results were obtained in a well one mile south of Fairview, at a depth of 380 feet.

Since we left the field the press reported that water was struck at 272 feet in a well drilled at Fairview. I have been informed by letter from a reliable source that the supply was not adequate and drilling was continued to a depth of 360 feet, with no new supply obtained.

To date no satisfactory results have been obtained by wells drilled in the Spirit River district. One well at the town of Spirit River was put down to 575 feet. As stated above, the top of the Dunvegan formation lies on the average 400 to 700 feet below the surface in these districts. To test this formation throughout its thickness at these places would add another 450 to 500 feet. Thus, drilling to 1100 feet in the deepest places or 800 feet where the Dunvegan is nearer the surface, should prove the possibilities of this formation as a water horizon for these districts.

An additional geological feature which is important in certain districts adjacent to those mentioned above is the thick accumulation of glacial deposits. These contain the water horizons for a long area of the Peace from Fairview east to Grimshaw.

There are glacial deposits within some parts of the areas referred to above, but the composition of these and their thickness are not suitable or of sufficient magnitude to carry any large supply of water.

2. *Precambrian Survey, Lake Athabaska.* That part of Canada in which the Precambrian rocks outcrop at the surface has been receiving increased attention during the past few years, due, in large part, to the discovery of important deposits of metallic minerals and also to the profitable results that have been obtained from the development of some of these deposits, particularly in Ontario, Quebec and Manitoba. The Precambrian igneous and metamorphic rocks come to the surface in the northeastern corner of Alberta, where they occupy an area of about 12,000 square miles.

One party, under the direction of A. E. Cameron, began field investigations on the Precambrian area in the northeastern corner of Alberta north of Lake Athabaska and east of Slave river. During the field season of 1929 about 200 square miles of country was examined. The survey of this part of Alberta will require

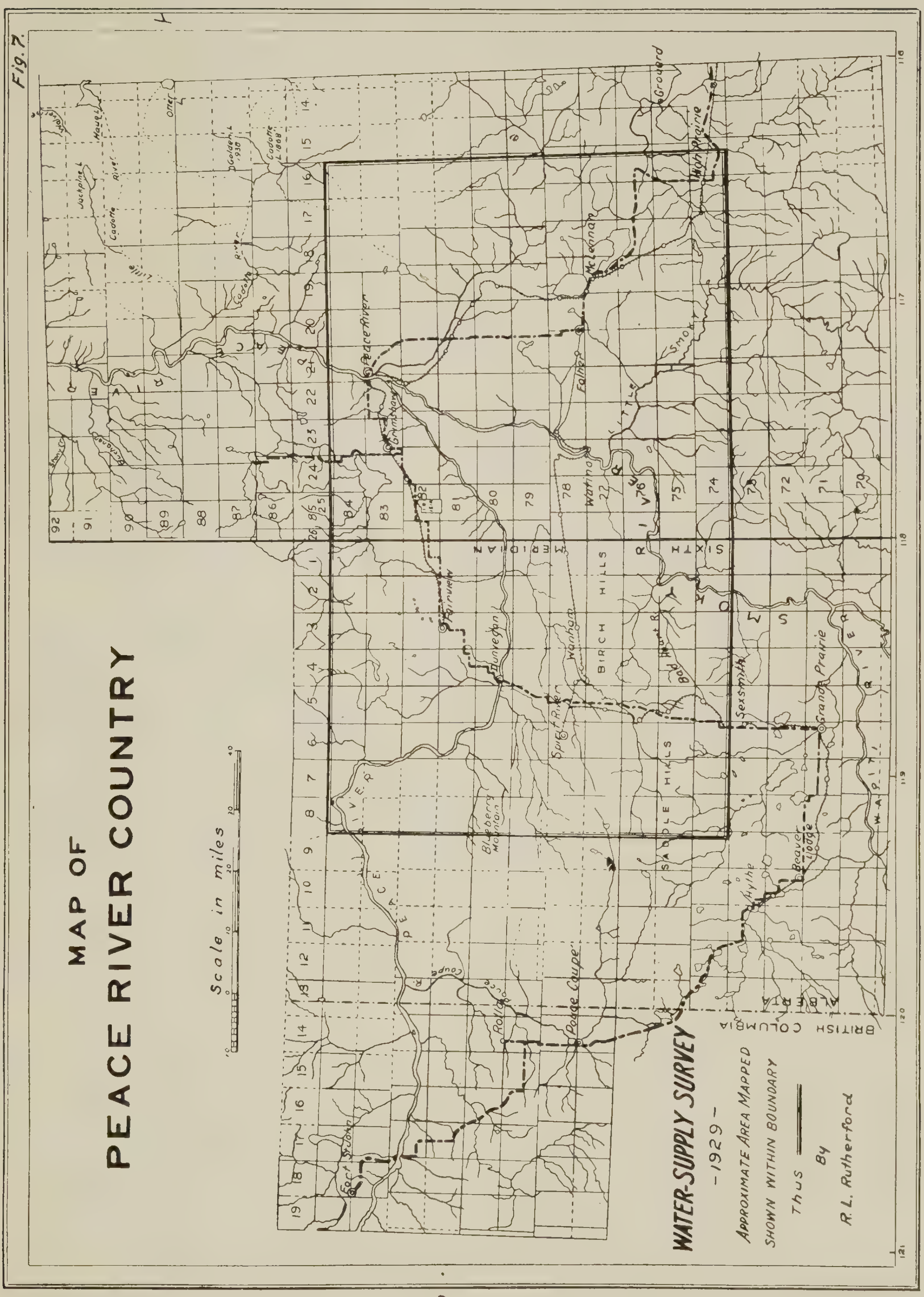


Figure 7—Map of Peace river country.

four or five years' field work before any precise geological information is available on the mineral possibilities of this part of the Province. On account of transportation difficulties, the progress of this work is slow, but Cameron made an important contribution to our knowledge. The progress of his work was greatly facilitated by the geographical information supplied by the Dominion Topographical Survey branch, in the map prepared from aerial surveys, an advance copy of which was supplied for our use. The results warrant the continuation of the survey and it is the intention to send another party into this same district this summer.

A report of progress on this work has been prepared by A. E. Cameron and is given below.

Report of Progress on Mineral Explorations in the Precambrian

By A. E. Cameron

A preliminary blue line copy of the map prepared from the aerial photographs taken in 1928 and covering approximately the south half of the Precambrian area of Alberta, north of Lake Athabaska, was received from the Surveyor General about May 15th. It was therefore decided, in consultation with Dr. R. C. Wallace, that the major part of the summer's field work should consist of examination of certain portions of this area.

The field party left Edmonton the last week of May and proceeded by rail and steamer to Chipewyan, Alberta. During June and July examinations were made of the territory immediately north of Athabaska lake between Sand Point and the east boundary of the province. June was spent in examination of the shore of Athabaska lake to familiarize the party with the rock association of the region. During July an extended trip was made into the lake district north of Athabaska lake. Some difficulty was encountered in locating a suitable route inland, due to a high rocky barrier which forms the north shore of Lake Athabaska. In all, twelve lakes were circumnavigated and 28 portages made. During these two months approximately 200 square miles of country was examined in some detail.

This territory was examined first principally because of the known occurrence (reported by F. J. Alcock) of a small area of ancient sediments, said to be equivalent to Keewatin series of eastern Canada, along the north shore of Athabaska lake west of Sand Point, and a study of the map suggested the possibility of an extension of these sedimentary rocks northward. The known mineral occurrences elsewhere in the Precambrian have always been associated with such remnants of ancient sediments within the granite and gneisses which compose the greater portion of the Precambrian areas. The field examination indicated a northerly extension of these Keewatin sediments as far north as time permitted the party to travel, but within the area no evidence of mineralization was found. It is evident that erosion has cut deep into the surface rocks in this area, and if any mineralization was ever present it has been eroded away.

The party returned to Chipewyan on July 27th and then spent two weeks examining rock outcrops on Slave river, between Athabaska lake and Fitzgerald, and traversing several of the small creeks tributary from the east. This examination indicated an association of rock types in this region generally similar to those further east. No definite Keewatin sediments were determined, but field examination suggests that much of the rock in the area is the product of absorption of sediments by intruding granite masses. As in the eastern area, no definite mineralization was found and all the evidence available seems to indicate that the area adjacent to the river is not likely to carry metalliferous values of any importance. Some time was spent in an examination of the district about Cariboo island where extensive staking was done in 1925-26. No more evidence could be found to indicate possible metallic mineralization here than elsewhere.

The party reached Fitzgerald on August 11th. On the 13th, through the kindness of Mr. W. G. Jewitt, of the Consolidated Mining and Smelting Co., I was flown, south, over the territory adjacent to Slave river, and had an excellent view from the air of the interior country which was beyond the range of canoe travel from Slave river. A day or two later Mr. Jewitt flew my assistant, Mr. H. S. Hicks, over the territory east and north of Fitzgerald on a general reconnaissance of that territory. These two flights although largely over territory of which we had at that time no map, gave us an excellent general idea of the country and an indication of the nature of the problem exploration therein entails. As a result of these reconnaissance flights, it was apparent that little further information could be obtained by short canoe trips east of Fitzgerald, but that an extended journey would be necessary. Moreover, our experiences on the small streams tributary to Slave river had indicated that these streams were rapidly becoming unnavigable for even canoe travel, due to low water. I therefore decided that no further field work could be successfully carried on within the Precambrian area this season.

Premier Brownlee and his party reached Fitzgerald on the 13th of August, and Dr. Wallace concurred in my decision to abandon further field work in the Precambrian for the season. I travelled with the Premier's party for about a week, visiting Fort Smith and flying north to the Northern Lead and Zinc Company's workings on Great Slave lake. I also accompanied Dr. Wallace on a rapid trip to visit the Salt springs west of Fort Smith. During that time my assistant made two or three additional flights with Mr. Jewitt, thereby becoming well acquainted with the general territory adjacent to Fitzgerald and Fort Smith.

The field party returned south by steamer with Premier Brownlee and his party to the junction of Peace and Slave rivers. On Dr. Wallace's instructions we left the steamer and proceeded up Peace river to make an examination and to sample the gypsum exposures on Peace river near Peace Point. A preliminary report on the gypsum deposits is given below.

To summarize the results of the season's operation, it may be stated that an area of approximately 200 square miles at the eastern

side of the Precambrian area of Alberta, and a further area of approximately 200 square miles adjacent to the east bank of Slave river have been examined in some detail. Although no definite evidence of metallic mineral occurrences of commercial importance resulted from the examinations, a good general knowledge of the various rock types and associations has been obtained and the ground-work thus laid for more extensive work. It should be pointed out that the season's operations have covered only about one-tenth of the total Precambrian area of the province, and although unsuccessful as far as indicating possible commercial development, this does not necessarily mean that the remainder of the area is not worth examination. From information obtained and from study of the aerial photographic map of the northern half of the area, received from Ottawa since my return from the field, I feel convinced that this northern area has distinctly greater possibilities than the portions examined during the past season.

The few aerial flights over the territory east of Fitzgerald by my assistant and myself convinced us that access to the interior country is going to prove exceedingly difficult if undertaken by canoe. This opinion is fully borne out by the map of the area received since our return to Edmonton. The water courses and lake basins all show a distinct north and south trend and thus travel east from Fitzgerald must be made across the trend of the country, necessitating many portages. In anticipation of further field work next season, it was felt that certain steps could well be taken this fall, and in conference with Dr. Wallace it was decided that caches of food supplies should be sent north this fall and placed at certain points in the interior by dog team this coming winter. Three hermetically sealed boxes, each containing food supplies for two men for two weeks, have been forwarded to Fitzgerald and arrangements made for their placement at certain definite points in the country east of Fitzgerald during the latter part of this winter.

In conclusion, it gives me great pleasure to report the very excellent service rendered by all the members of my party. Particular credit is due my assistant, Mr. H. S. Hicks, whose previous experience in similar work and unfailing industry and initiative were largely responsible for the success of the field operations.

3. *Jasper Park.* Each year a short time is spent on field investigations on the geology along the Athabaska valley within the mountains west of Edmonton. By working out the succession of formations about the structure within the mountains, much valuable information is obtained, not only on the geology of the Rocky mountains but on the geology under the foothills and plains, because many of the formations exposed within the mountains extend eastward across Alberta and occur under varying thicknesses of younger formations that are not represented in the mountains.

R. L. Rutherford and P. S. Warren spent a few days in the spring obtaining more data on the Athabaska section west of the foothills. Fossils collected at many points are now being studied and classified.

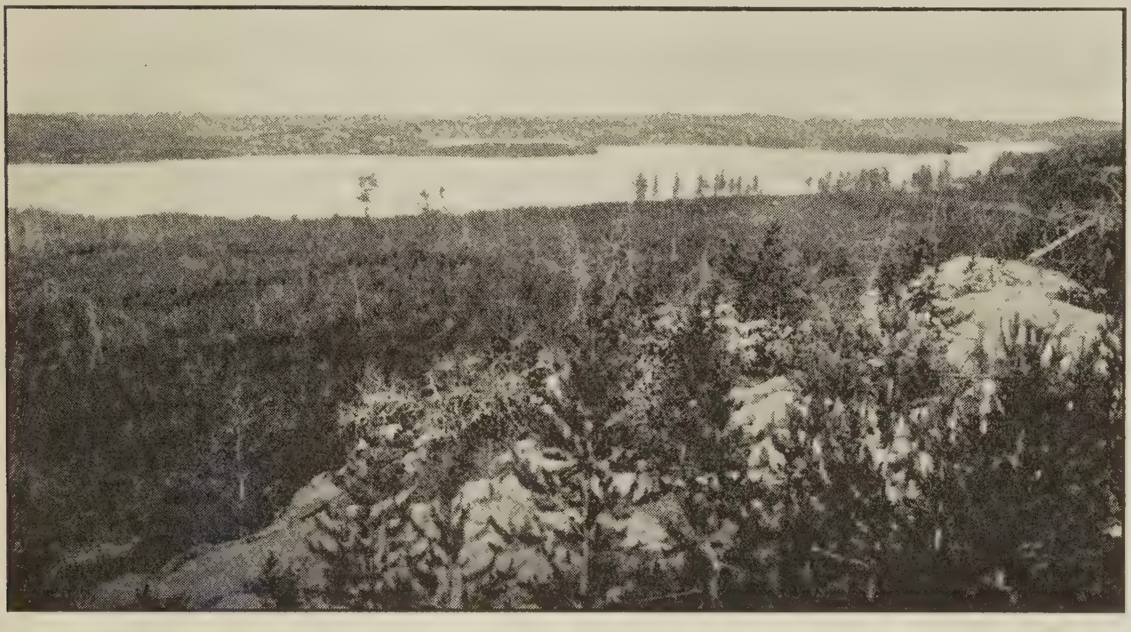


Figure 8—Looking west across Florence lake. Granite gneiss in hills in background.

Figure 9—Wylie lake from portage to Bryant lake. Granite gneiss in foreground.

Already fairly complete sections have been made by the Geological Survey of Canada, across the Rocky mountains in the southern part of Alberta in the Crowsnest district and also across the mountains in the vicinity of Bow valley. Supplementary information has been added by our own surveys. It is the intention to continue our field work along Athabaska valley and it is hoped that some of the data will be ready for publication during the current year.

The possibilities within the mountains of mineral occurrences of sufficient quality and quantity to be valuable commercially have not yet been extensively explored. Reports of gypsum deposits in western Alberta have been recorded for some years and attractive specimens of gypsum have been brought to the office for examination. In consequence about a week was spent on a field survey within the front ranges of the mountains investigating the reported occurrence of a deposit of gypsum. This is not an extensive deposit, but its stratigraphical horizon has been traced to the Athabaska valley. The occurrence warrants further investigation as workable deposits of gypsum might prove valuable if found close to the railway. During this preliminary work in the east side of the park, strata were encountered that have not been previously recorded in this particular part of Alberta. It is planned to obtain additional data during 1930.

4. *Plains and Foothills.* About two and one-half months in the summer of 1929 were spent by L. S. Russell in continuation of the survey commenced by him in 1928. In 1928 his studies in the field were made in the outer foothills and adjacent plains between the International Boundary line and the Bow river. Most of the time in 1929 was spent on a corresponding belt between the Bow and North Saskatchewan rivers.

The principal objects of this survey may be summarized as follows: Stratigraphic correlation of the formations above the Bearpaw in the southern plains section, the southern foothills section, the northern plains section, and the northern foothills section. Tracing of the Cretaceous-Tertiary boundary in the southern half of Alberta. Determination of the faunal succession in the various sections mentioned above. Correlation of the post-Bearpaw formations in Alberta with sections in Montana and elsewhere. More detailed knowledge on the succession of geological events in the southern half of Alberta during late Cretaceous and early Tertiary time.

The information obtained is of importance in its relation to geological investigations over a large part of Alberta.

The extensive collections of fossils made by Russell during the last two seasons, as well as collections made by our surveys at other times in these areas, are at present the object of special investigation by Russell, who is completing his doctorate work at Princeton University. Many of the specimens of special stratigraphical significance are being compared with type material in the larger national museums in Canada and the United States.

Russell's dissertation will include detailed discussion of all information known to date on this part of the stratigraphical succession in Alberta south of the North Saskatchewan river. It is

planned to publish the results of his investigations as one of our reports.

He has already published the following papers on fossil material collected by our surveys and related to the specific problem on which he is working:

"Mollusca of the Paskapoo Formation in Alberta," L. S. Russell, Trans. Roy. Soc. Can., Ser. 3, Vol. 20, Sec. 4, pp. 207-220, 3 pls., 1926.

"A New Fossil Fish from the Paskapoo Beds of Alberta," L. S. Russell, Amer. Jour. Sci., Vol. 15, pp. 104-107, 4 figs., 1928.

"Paleocene Vertebrates from Alberta," L. S. Russell, Amer. Jour. Sci., Vol. 17, pp. 162-178, 5 figs., 1929.

"Upper Cretaceous and Lower Tertiary Gastropoda from Alberta," L. S. Russell, Trans. Roy. Soc. Can., Ser. 3, Vol. 23, Sec. 4, p. 81, 1929.

5. *Gypsum Along Peace River.* During the summer of 1929 A. E. Cameron spent about a week examining an extensive deposit of gypsum which occurs along the banks of Peace river in the vicinity of Gypsum point.

During this examination ten sections were measured and seventeen representative samples were collected and have been analyzed.

Although no definite information was obtained by Cameron regarding the probable quantity of gypsum in this area, he is of the opinion that the deposits are much more extensive than previous investigations have indicated.

A report on the occurrence and analyses of these deposits by Dr. Cameron is given below.

The Gypsum Deposits on Peace River

By A. E. Cameron

Introduction.

The presence of extensive deposits of gypsum occurring in Palaeozoic sediments exposed on lower Peace river near Little Rapids has long been known. The first attempt to study these deposits was that made by Camsell[1] in 1916. He reports as follows:

"On Peace river gypsum is exposed on both banks of the river almost continuously for a distance of 15 miles or so from Little Rapids to a point 5 miles below Peace Point. The exposed thickness varies from a few feet to a maximum of 50 feet, the latter occurring on the south side of the river at the foot of the rapids. The gypsum is usually white and massive. In places it is earthy and thin-bedded, or holds narrow bands of dolomitic limestone. Selenite is rare, but thin beds of satin spar are common. Anhydrite is occasionally present in rounded nodules or in thin beds. Overlying the gypsum is a fractured and broken bed of limestone, but since the structure of the beds is undulatory, the gypsum is frequently brought up to the top of the cliffs and has no cover except the drift, the limestone having been removed by erosion. The drift varies in thickness from 5 to 15 feet and when gypsum is covered only by the drift the conditions are most favourable for the economical mining of the beds. Such conditions occur in a

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[1]Camsell—Salt & Gypsum Deposits of the Region between Peace and Slave Rivers, Northern Alberta. G.S.C. Summary Report 1916, p. 134.

number of localities in the section, particularly on the north side of the river.

"Judging by the character of the surface back from the face of the cliff, gypsum must extend back from the river for a considerable distance. Taking an exposed length of 15 miles along the river and an average thickness of 15 feet of gypsum and assuming the beds extend back from the river at least a distance of a quarter of a mile on either side of the river, the quantity of gypsum in the Peace river section is at least 217,000,000 tons. A considerable portion of this is very favourably situated for mining on account both of the location and the thin overburden of drift."

Camsell also states: "No attempts have been made to work any of the gypsum deposits because of their remoteness from settled districts where gypsum products could be used, and indeed no claims have as yet been taken up on them."

Since Camsell wrote the above, much progress has been made in the technology of gypsum and markets have greatly widened. Evidence of this is shown in the production and value figures for gypsum produced in Canada in the two years 1916 and 1928, given in Table I.

TABLE I.

Production of Gypsum in Canada for years 1916 and 1928.

Grade	Quantities, Tons		Values, Dollars		Value per ton, Dollars	
	1916	1928	1916	1928	1916	1928
Lump	249,893	43,224	263,050	80,467	1.05	1.86
Crushed	15,680	1,018,172	28,111	1,770,077	1.79	1.74
Fine Ground	6,096	9,567	19,673	55,170	3.23	5.77
Calcined	71,246	175,396	427,759	1,837,934	6.00	10.49

Consumption of Gypsum in Canada during the same years is shown in Table II.

TABLE II.

Consumption of Gypsum in Canada for years 1916 and 1928.

Grade	Crude or uncalcined—Tons		Calcined Tons		Total Tons	
Years	1916	1928	1916	1928	1916	1928
Production	271,669	1,070,972	71,246	175,396	342,915	1,246,368
Imports	3,305	1,353	3,786	10,563	7,091	11,916
Total	274,974	1,072,325	75,032	185,959	350,006	1,258,284
Exports	221,156	824,536	....	8,232	221,156	832,768
Consumption	53,818	247,789	75,032	177,727	128,850	415,516

Table No. II shows that the consumption of gypsum in Canada has increased almost fourfold in the last twelve years, and it would seem that the gypsum deposits on Peace river, if of suitable quality, would be, at a comparatively early date, a factor of importance in the development of the natural resources of northern Alberta. The writer was therefore instructed to make preliminary examination of these gypsum exposures to determine their quality and accessibility for mining. A total of about one week during the latter part of the field season of 1929 was spent in the district. The examination was restricted to measuring and sampling certain sections of the exposures. In all, 10 sections, at intervals of a mile to two miles on the north side of the river were measured and 17 samples taken for analyses.

Sections.

All sections except No. 1 were unit sections measured vertically on an exposed cliff. Section No. 1 is a composite section giving maximum thickness of beds exposed along a distance of about one-quarter mile.

Description of each section measured, together with its approximate location and identification of particular beds in each section which were sampled follows.

Section No. 1. North side Peace river at Peace Point.

Bed No.	Strata.	Thickness.	Sample No.
1	Surface till and glacial clays	2′	
2	Brecciated dolomite	18′	
3	Thin bedded grey gypsum	9′6″	
4	Massive white to light grey gypsum with thin stringers of fibrous gypsum parallel to and cutting massive beds	6′	1
5	Massive white saccharoidal gypsum	3′4″	2
6	White gypsum with lenses of grey anhydrite	3′3″	3
7	Massive white to grey gypsum to river level	10′	4
	Bottom not exposed.		

Section No. 2. South side of river at Peace Point.

Bed No.	Strata.	Thickness.	Sample No.
1	Glacial lacustrine sands and silts	50′ (approx.)	
2	Massive grey gypsum	17′5″	5
3	White flinty hard gypsum	8′	6
	Bottom not exposed.		

Section No. 3. North side Peace river about 2 miles above Peace Point. West limb of a flat anticline, dipping 35°E. West end of exposure is cut off by sharp syncline bringing down brecciated dolomite and thin bedded flaggy dolomite to river level.

Bed No.	Strata.	Thickness.	Sample No.
1	Thin bedded shaley grey anhydrite and gypsum	12′3″	
2	Massive grey saccharoidal soft gypsum	5′6″	7
3	Interbedded massive white gypsum with lenses of hard grey gypsum	11′	8
4	Massive grey to white saccharoidal soft gypsum	4′	
5	Hard white gypsum with thin layers of dark shale and some white fibrous gypsum	2′5″	9
6	Massive soft grey to white saccharoidal gypsum to river level	4′5″	
	Bottom not exposed.		

Section No. 4. North side Peace river about 4 miles above Peace Point. Vertical cliffs of purple tinted gypsum with interbedded dolomite are exposed as a broad anticline, apparently pitching steeply to the north. The section was measured at crest of this structure where strata are lying practically horizontal.

Bed No.	Strata.	Thickness.	Sample No.
1	Loam, silt and sand	10′	
2	Thin bedded dolomite and gypsum	5′	
3	Massive soft white gypsum with thin stringers of dark shale	12′	10
4	Interbedded dolomite and gypsum with gypsum impregnated dolomites	7′	
5	Hard dark grey gypsum	10′5″	11
6	Interbedded dark grey anhydrite and white gypsum, probably lensy	9′5″	
7	Massive hard flinty gypsum to river level	7′	
	Bottom not exposed.		

Section No. 5. North side Peace river, about 4 miles below Little Rapids and at eastern end of Gypsum cliffs which are continuous on north side of river from Little Rapids to this point. Strata are practically flat lying with broad gentle folds periodically bringing dolomites down to river level.

Bed No.	Strata.	Thickness.	Sample No.
1	Loam, silt and sand	3′	
2	Intimately interbedded white to grey gypsum and dark hard siliceous gypsum	18′	12
3	Interbedded gypsum and dolomite	2′	
4	Grey white saccharoidal gypsum	4′(part)	13
5	Thin bedded dolomite with fibrous gypsum seams and stringers	3′3″	
6	Soft bluish white gypsum	6′(part)	13
7	Hard bluish white anhydrite with seams and stringers of gypsum	9′	
8	Soft bluish white gypsum	3′(part)	13
9	Hard, creamy colored, shaley dolomite with thin seams and stringers of gypsum	2′5″	
10	Massive soft brown to white gypsum	3′(part)	13
11	Dark brown hard anhydrite	1′	
12	Massive soft white gypsum with brown stringers	4′(part)	13
	Bottom not exposed.		

Section No. 6. North side of river about 2 miles below Little Rapids. Vertical cliffs of gypsum up to 50 feet high. Only the lower 25 feet available for sampling.

Bed No.	Strata.	Thickness.	Sample No.
1	Sand, silt and loam	20′	
2	Massive white to grey gypsum	25′ to 30′	
3	Massive white to grey, soft gypsum, some layers saccharoidal	25′	14
	Bottom not exposed.		

Section No. 7. North side Peace river about 1 mile below Little Rapids. Vertical cliffs of soft white to grey gypsum with lower 18 feet only available for sampling.

Bed No.	Strata.	Thickness.	Sample No.
1	Loam, silt and sand	10′ to 16′	
2	Massive grey gypsum	15′ to 20′	
3	Massive soft grey saccharoidal gypsum	18′	15
	Bottom not exposed.		

Section No. 8. South side of Peace river about 2 miles below Peace Point. Cliffs of white to grey gypsum are exposed for a distance of about one mile. Above the cliffs and south about 500 feet, are sands and silts to a thickness of 65 to 100 feet (estimated).

Bed No.	Strata.	Thickness.	Sample No.
1	Loam, sands and silt	?	
2	Thin bedded limestone or dolomite	10′	
3	Thin bedded shaley anhydrite or hard gypsum..	12′	
4	Massive hard white gypsum	8′	
5	Interbedded hard white gypsum and dark shale	6′	
6	Massive hard white gypsum as at base of section 2	5′	
	Bottom not exposed.		

Owing to the proximity of section No. 2, and the apparent continuity of the strata between the two sections, no samples were taken at this point.

Section No. 9. North side of Peace river about 3 miles below Peace Point. Cliffs 25 to 50 feet high are exposed all along this bank of the river for over one mile. They show as gently undulating beds of limestone and gypsum. The cliffs are practically inaccessible, but at one spot about 200 yards from the west end of the outcrop, the bottom 12 feet off beds could be sampled.

Bed No.	Strata.	Thickness.	Sample No.
1	Sand, silt and talcs	10′ to 15′	
2	Thin bedded flaggy dolomite	8′ to 12′	
3	Massive soft saccharoidal gypsum	18′ to 20′	16
	Bottom not exposed.		

Section No. 10. This section was measured only 100 feet upstream from No. 9, and it conforms with that section. It was sampled in order to determine if the very apparent changes in the appearance of the gypsum noted over this short distance was accompanied by a corresponding change in quality.

Bed No.	Strata.	Thickness.	Sample No.
1	Sand, silt and talcs	15′	
2	Flaggy limestone or dolomite	10′ to 12′	
3	Thin bedded hard white to dark grey gypsum	18′	17
	Bottom not exposed.		

The change in appearance and physical character noted in the gypsum of sections 9 and 10 is characteristic of these gypsum deposits. Given horizons or beds can be traced in a few hundred feet from a dense, hard, white to grey, thin-bedded material, to a coarse, soft, massive, saccharoidal type. The corresponding change in chemical nature is well shown in the comparison of analyses of samples 16 and 17 given in the table. An appreciable decrease in SO_3 content is shown, but the practical absence of any change in ignition loss indicates that the change is not due to the presence of anhydrite, and the change in physical character must be assumed as due to the increased silica content shown in sample No. 17.

Sampling.

Owing to the inadequacy of the equipment available and the inaccessibility of the gypsum cliffs, proper channel sampling was impossible. The following sampling method was therefore adopted.

Chip samples were collected from the previously cleaned exposed surface of the beds by chipping off approximately equal quantities from each few inches of strata, making a total of about 20 to 30 pounds per sample. The chips so collected were then crushed by a hammer to about ¼-inch maximum size, coned and quartered on a canvas sheet until the sample was reduced in weight to not less than 5 pounds. On arrival at the University laboratories each sample was ground in a Braun pulverizer to 60 mesh and riffled to sample for analysis. Although the exposed surface was carefully brushed previous to sampling, it was found impossible to completely clean the surface of river silt and soil, and hence the samples all probably carry a slightly higher silica content than would be found in freshly exposed gypsum.

Analyses of the samples of gypsum obtained are given in Table III. These analyses were made by J. A. Kelso, in the Industrial Laboratories at the University of Alberta. The table shows also the number of sections from which the sample was taken and the actual thickness of strata represented by each sample. The majority of the samples represent single beds in a given section, but in certain cases, as Nos. 1 to 9 and 13, a composite sample has been taken over two or more beds when it appeared that simple sorting at the quarry would separate out the interbedded impurities throughout a considerable thickness of section.

TABLE III.

Analyses of Gypsum from Gypsum Exposures on Peace River

Sample No.	Section No.	Bed No.	Thick-ness Strata Ft.	SiO_2 %	Fe_2O_3 Al_2O_3 %	MgO %	CaO %	SO_3 %	Ignition Loss % (H_2O etc.)	Gypsum SO_3 cal.
1	1	3 & 4	15′6″	2.54	0.92	2.02	31.58	42.10	20.74	90.34
2	1	5	3′4″	1.10	0.74	0.30	32.56	45.30	19.95	97.21
3	1	6	3′3″	1.76	0.96	4.54	32.19	34.83	25.59	74.74
4	1	7	10′0″	0.82	....	....	32.63	45.60	21.00	97.85
5	2	2	17′6″	1.42	....	0.20	31.82	45.00	21.37	96.57
6	2	3	8′0″	4.18	1.10	0.30	31.39	43.10	19.98	92.49
7	3	2	5′6″	1.34	....	0.25	31.64	45.20	21.43	96.99
8	3	3	11′0″	2.04	....	0.33	31.80	44.32	21.34	95.11
9	3	4, 5 & 6	11′0″	1.46	....	0.31	31.80	44.70	21.74	95.93
10	4	3	12′0″	0.58	....	0.20	32.11	46.00	20.50	98.71
11	4	5	10′5″	1.48	....	0.20	32.00	45.00	21.37	96.57
12	5	2	18′0″	6.28	....	0.76	30.97	41.09	20.80	88.18
13	5	4, 6, 8 10 & 12	16′6″	1.04	....	0.22	32.18	46.02	20.54	98.95
14	6	3	25′0″	0.64	....	0.22	32.18	45.91	21.02	97.52
15	7	3	18′0″	1.42	....	0.10	32.50	45.68	20.24	98.02
16	9	3	18′0″	0.88	....	0.30	32.35	45.60	20.57	97.85
17	10	3	18′0″	5.02	0.60	0.40	31.24	42.50	20.15	91.20
Average of 26 analyses of commercial samples quoted by Eckel[1]				0.51	0.36	0.33	32.60	45.30	20.83	97.20
Average of 24 analyses of commercial samples quoted by Stone[2]				0.77	0.81	1.01	32.46	44.66	20.27	95.90

[1] Eckel—Cements, Limes and Plasters, Wiley & Co.

[2] Stone—Gypsum Deposits of United States, U.S.G.S. Bull. 697.

Economic Possibilities.

The past season's field work in the gypsum area was limited to the measuring and sampling of the sections described above. From the rather general examination made, it appears as though Camsell's estimate of 217,000,000 tons is quite conservative. The sections described indicate that the average thickness of the gypsum beds is very considerably in excess of the 15 feet assumed by Camsell, while the broad meanderings of the Peace river clearly show an area of at least 60 square miles as underlain by the gypsum series as against the 8 to 10 square miles used by him. Altogether it would appear that Camsell's estimate can be increased at least five times and the figure would still be quite conservative.

Peace river forms a ready means of access to much of the gypsum. It has cut deep into the gypsum seams and at a number of points has removed much of the overburden so that large quantities of material are very favorably situated for mining or quarrying. Transportation of materials to and from the area can be had at present only by barge or scow on Peace and Athabaska rivers to rail head at Waterways, a distance of about 300 miles, most of which is upstream movement for the gypsum.

The nearest market point would appear to be Edmonton, 300 miles from Waterways.

The Canadian Pacific Railway quotes 41 cents per hundred pounds as a special commodity freight rate on plaster from Winnipeg to Edmonton, equivalent to $8.20 per ton. With the average value of $10.49 per ton for calcined gypsum, shown in Table I added, the laid down cost of plaster at Edmonton from Manitoba should not exceed $20.00. The price of plaster laid down on the Edmonton market, imported from Heath, Montana, is $23.00 per ton, and that from Manitoba is $22.50 per ton. It should be noted, however, that the Manitoba Gypsum Company is undertaking development of a gypsum works at Calgary, using gypsum from the Crowsnest Pass area of British Columbia, and that presumably this figure can be appreciably lowered when this product reaches the market. Local dealers report that 8,000 tons is about the annual consumption of gypsum products in the Edmonton district.

To meet this price, gypsum from Peace river must be mined or transported by barge or scow to Waterways and by rail to Edmonton. It is assumed that a milling and calcining plant would be situated either at Waterways or Edmonton, and not at the quarry as thus fuel, labor and other supplies would be much more readily available. Assuming that mining and treatment costs would be approximately the same as at other gypsum points in Canada, transportation charges on raw gypsum from Peace river to Waterways and on products from Waterways to Edmonton would appear to be the controlling factors.

Cost of up-river transportation is problematical. The Alberta and Arctic Transportation Company (subsidiary to Hudson's Bay Company) advise that they handle fish scows from Athabaska lake to Waterways at $300.00 per trip. Each scow carries about 200 tons. They report that it costs from $35,000 to $40,000 per season

for handling freight alone. A steamer can handle two loaded scows or about 400 tons per trip, up-stream. It would take about one week for a round trip between Peace Point and Waterways, or with 20 weeks open navigation per season, a total of 8,000 tons could be handled per steamer. These figures would indicate a transportation cost of $2.50 per ton of gypsum between Peace Point and Waterways.

The Alberta and Arctic Transportation Company has two steamers on the river operating between Fitzgerald and Waterways. The large steamer could handle two scows of 200 tons capacity each and the smaller steamer two of 100 to 150 tons capacity each. They could pick up these scows at the junction of Peace river and Rocher river and return them empty to the same point. Presumably these could be handled at not over $400.00 per scow. In a 20 weeks' season this would allow a movement of about 14,000 tons of gypsum to Waterways for $32,000, or a little over $2.30 per ton. To this would have to be added transportation costs from Peace Point to the steamer, which can be estimated at about 70 cents per ton, and transfer charge from scow to car at Waterways at perhaps $2.00 per ton. A freight rate on the Northern Alberta railways from Waterways to Edmonton pro rata with the rate from Winnipeg to Edmonton would add about $3.10 to the transportation costs. Under these conditions transportation of gypsum from Peace Point to Edmonton should not exceed $8.00 per ton or approximately the present freight rate between Winnipeg and Edmonton. It would seem that with cheap mining costs and cheap fuel, a gypsum plant at Edmonton or at Waterways, using Peace river gypsum, should be able to compete with gypsum from Manitoba in the Edmonton market.

In conclusion it should be noted that records of wells drilled at Waterways for salt have shown numerous beds of gypsum at depths of 500 to 600 feet. This could probably be mined at a cost not exceeding $3.50 per ton, or appreciably less than the cost of water transportation from Peace Point to Waterways. On the other hand, the capital outlay required for these mining operations would be much greater than that required for quarrying operations at Peace Point, and the necessary scows for transportation up river.

It is suggested that further information on the gypsum series would be of value, and a field party could profitably be sent to the area equipped to make proper channel samples and measurements of quantities, and to also investigate in some detail the best localities for immediate operations. Although not a large scale operation, an output of 14,000 to 15,000 tons per season would meet the needs of the Edmonton district and would certainly create revenue producing traffic on the Northern Alberta Railway.

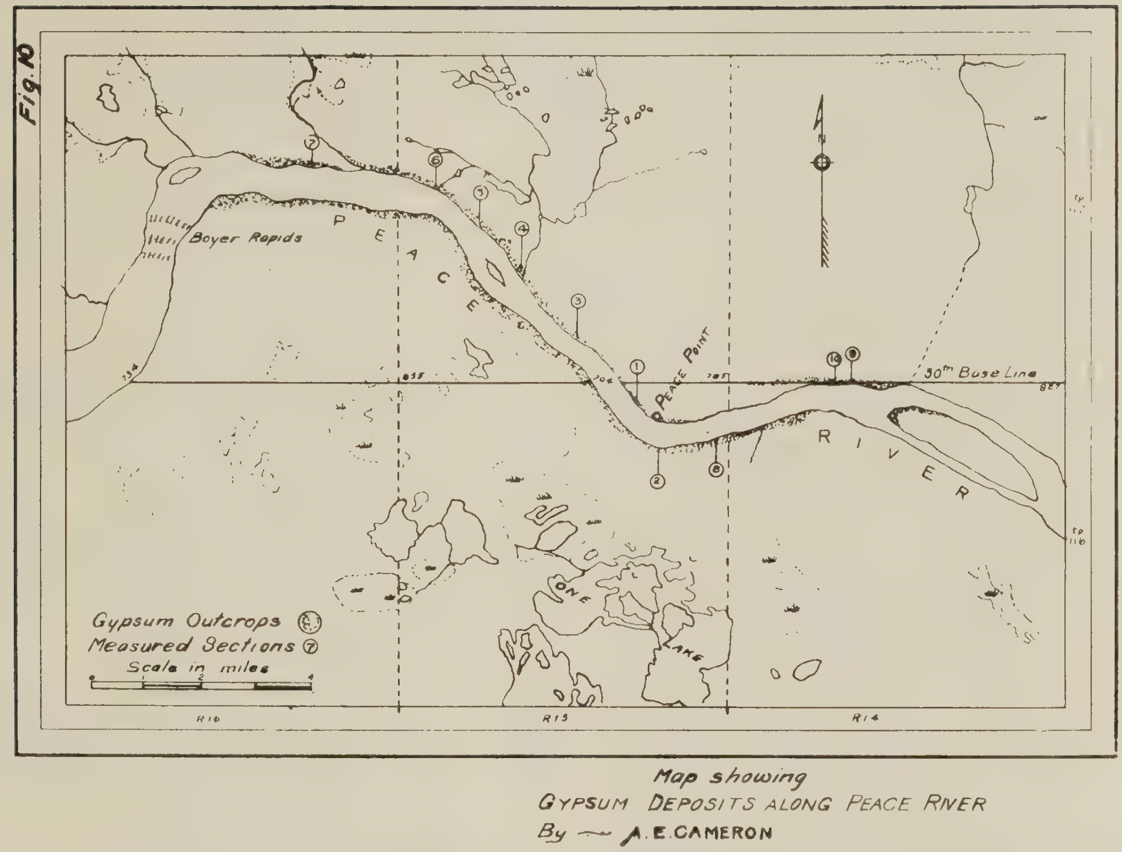

Figure 10—Map showing gypsum deposits along Peace river.

ROAD MATERIALS DIVISION

K. A. Clark and D. S. Pasternack

A two years programme of bituminous sand investigations was adopted by the Research Council early in the year, but this was modified in May because of the co-operative agreement entered into with the Department of Mines at Ottawa.

The original programme included studies of practical methods of mining bituminous sand, further separation plant operations on a semi-commercial scale and study of the use of the separated bitumen in practical ways; the revised programme permitted concentration on the second item.

A new laboratory separation plant was assembled during the winter to test out various features of design that had been suggested by previous studies and which might be used in the semi-commercial plant to be operated.

As a first step towards investigating practical methods of mining bituminous sands Mr. Robert Halpenny, of the Sterling Collieries, was engaged to visit the bituminous sand deposits at McMurray and to report on the feasibility of using a steam shovel for mining. Mr. Halpenny went to Waterways during the first week of May. He recognized that bituminous sand was an unusual material for handling with steam shovel but recommended the trial of a ruggedly constructed shovel equipped with an undersized dipper, and was confident that it would work satisfactorily.

Early in May an agreement was reached with the Dominion Department of Mines which in essence permitted the Research Council to devote its energies almost entirely to commercializing our separation process. This agreement, and an accompanying programme of work, is attached to the end of this report.

The committee, appointed to control the co-operative efforts, consists of Dr. H. M. Tory, chairman, Dr. C. Camsell and Dr. R. C. Wallace.

Separation Plant at Dunvegan Yards

A diagrammatic drawing of the plant at Dunvegan Yards, built and operated in 1925, is given in Figure 11. The bituminous sand was elevated by a bucket line and discharged into a set of rolls. The material then entered a mixing and heating machine. Along with the bituminous sand, a stream of three per cent. silicate of soda solution and of plain water was introduced. The blades of the machine moved the feed forward while submitting it to a stirring action. Heating was accomplished by a bank of steam coils around the outside of the trough, but principally by live steam jetted into the bituminous sand.

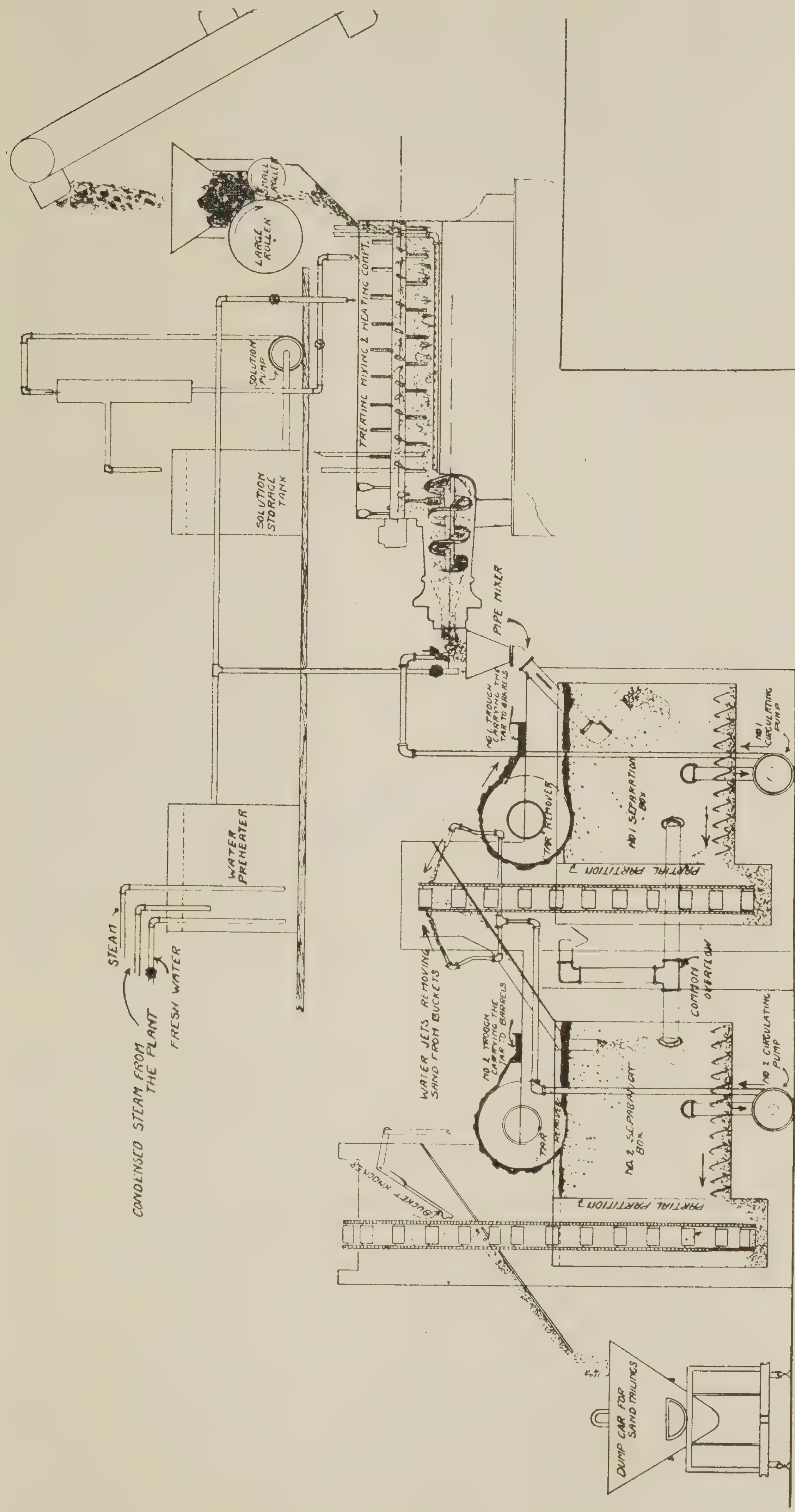

Figure 11—Separation Plant built in 1925.

The mixing machine prepared the bituminous sand for separation. Laboratory work on batch samples of the particular material handled in the large plant had shown that this preparation required that the sand be heated to 85°C and thoroughly mixed with approximately 20 percent of its weight of silicate of soda solution of two percent concentration. This gave a mixture similar in consistency and texture to brick mortar. There was no excess of solution and no separation of bitumen. In the larger, continuous operation, there was no means for definitely proportioning solution against a given quantity of bituminous sand. A stream of three percent solution was consequently used, since there would be dilution by the condensed steam used for heating. The size of the stream was regulated by observing the consistency of the discharge, and if this became too stiff, a small stream of plain water was introduced till conditions became normal again.

The treated bituminous sand was discharged by the mixing machine into a funnel. A stream of hot water also ran into this funnel and swept the sand down a pipe into a large tank filled with hot water. The separation of bitumen from sand took place in this pipe. The bitumen dispersed in the hot water stream as tiny droplets, leaving the sand clean. In the quiet water of the large box, the sand was free to sink to the bottom while the bitumen floated to the surface forming a black buoyant froth.

Several features of the separation box should be noted. A centrifugal pump was connected to it some distance above the bottom and forced a stream of hot water up to a discharge into the funnel which connected back into the separation box. Thus a constant stream of hot water for washing the treated bituminous sand was provided. The liberated sand, on reaching the bottom, was moved into a boot by a screw conveyor. From the boot, the sand was elevated by a bucket line. A large steel wheel was set over the top of the box so that it dipped to the bottom of the layer of bitumen floating on the top of the hot water. On slowly revolving, the wheel picked up the bitumen and delivered it to a scraper which diverted it into a trough leading to storage.

The sand elevated from the boot of the first separation box was discharged into a pipe leading into a second separation box. Since the fine wet sand would not drop from the buckets, it was necessary to wash it out by water jets provided by the circulating pump connected with the second separation box. The action of this second box was similar to the first one and was designed to clean up the tailings before discharging them to the dump. The buckets of the elevator from this box were made to discharge their loads of sand by striking them with a mechanical knocker.

This separation plant operated well, but nevertheless had a number of shortcomings. There was no way of measuring with any exactness the quantity of bituminous sand passing through the plant in a given time. Neither was there any way of measuring out the proper quantity of silicate of soda solution for treatment. The bucket lines for eliminating tailings from the separation boxes were troublesome and unsatisfactory. Besides being troublesome mechanically, they were wrong in principle in that they elevated

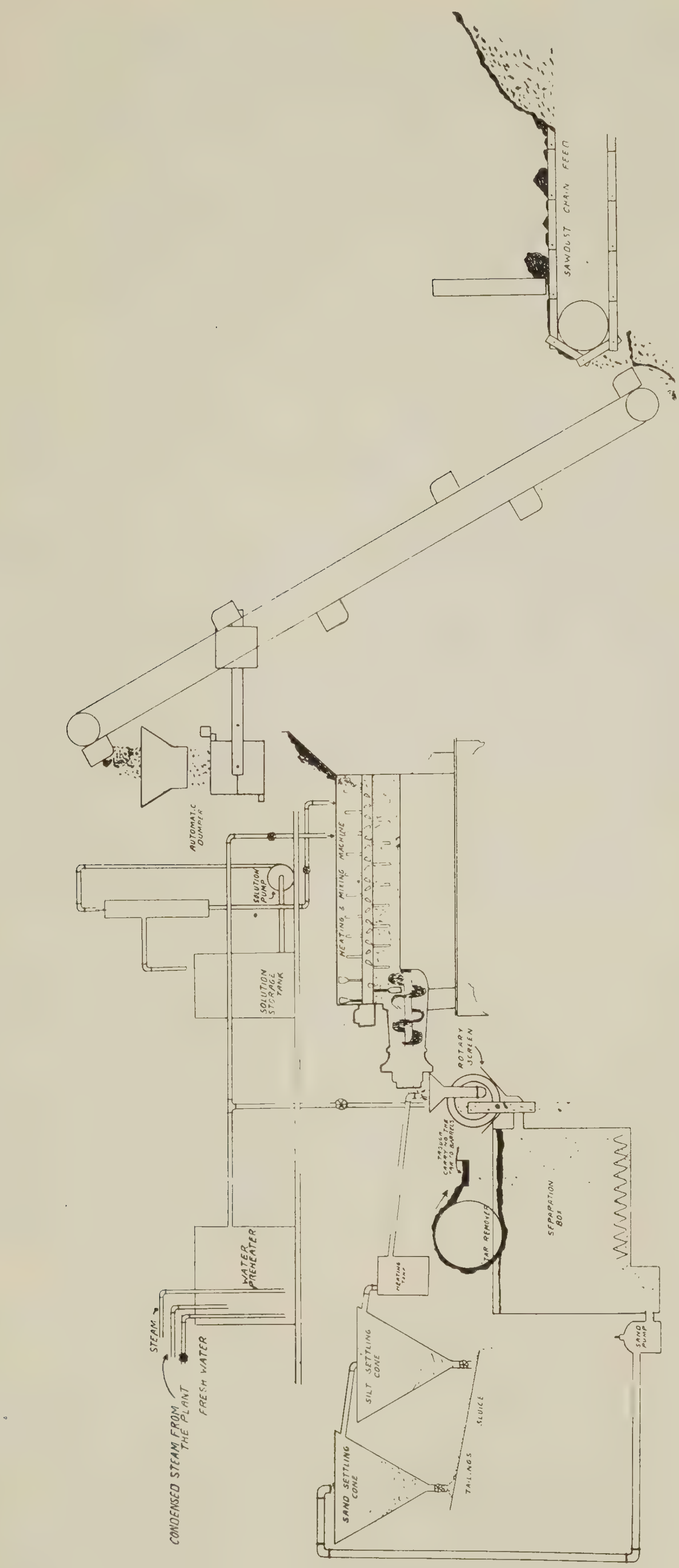

Figure 12—Separation Plant, 1929.

the tailings through the bitumen layer on the surface and caused a loss of bitumen. There was no means for cleaning the plant water, and it soon became heavily charged with solids. The silicate of soda used in treatment accumulated in it and helped to hold the silt of the bituminous sand in fine suspension. Finally the muddy water retarded the settling of the fine sand. The solid content of the circulating water was observed to rise to as great as twenty percent. The second separation box was of little use. The quantity of bitumen that collected on its surface was small. The final discharge of tailings from a bucket line was mechanically unsatisfactory.

These and other problems had been made the subject of laboratory work during the years from 1925 to 1928, and means for meeting them had been studied. A new laboratory plant had shown these to be feasible. Consequently the way was prepared for the remodelling of the larger plant.

The modified plant is indicated diagrammatically in Figure 12. A mechanical arrangement for moving bituminous sand from the stock pile into the plant was installed. This consisted of two sawdust chains side by side moving about six feet a minute from under the stock pile and then under a strong barricade which fitted close down against the chain. Small fragments of material settled into the links of the chain and were moved to the boot of the bucket elevator. The chain also caught the corners of lumps, shearing them off and loosening the set of the stock pile by the movement it gave them. Lumps carried forward were stopped by the barricade and gradually sheared to pieces. No pieces of more than 1½-inch size were delivered to the plant. Consequently the rolls were dispensed with.

The discharge from the bucket line was caught in an automatic dumping hopper. The hopper accumulated bituminous sand till its counterweight was lifted and then dumped. The contrivance worked well and can be made to serve several useful purposes. A tally can be attached to it so that the quantity of material fed to the plant during any period of time can be determined. Further, since the feed is in this way broken into units of definite weights, it is a simple matter to synchronize with the hopper similar dumping apparatus which will deliver to the plant simultaneously with these units the proper quantities of reagent solutions for their treatment and other purposes.

The blades of the mixing machine were overhauled and rearranged and their mixing action much improved.

The treated bituminous sand and stream of circulating hot water were passed through a self-cleaning rotary screen before passing into the separation box. This was a great improvement. A miscellaneous collection of wood chips, fuse, pebbles of various sizes, ironstone nodules as well as shaly fragments of bituminous sands which defy treatment and separation were caught and eliminated instead of passing along the plant and causing trouble.

It has been found that the accumulation of solids in the plant water can be satisfactorily overcome by adding a water-soluble

salt of a divalent or trivalent metal, as, for example, calcium chloride. This precipitates the silicate of soda and coagulates the silt and clay suspension. Opportunity, however, has to be allowed for the precipitate to settle.

The second separation box was eliminated from the modified plant. In its place two settling cones were provided, one for eliminating sand tailings, and the other for clearing the plant water of precipitated silicate of soda and mud. These were placed at such elevation that their overflow would run, with a few feet of head, back to the separation box and provide the circulating stream needed for washing the treated bituminous sand from the mixer into the separation box.

A stream of sand and water was pumped by a diaphragm pump, capable of handling gritty material, from the boot of the separation box to the sand settling cone. As large a proportion of the overflow as the second cone would clarify was passed through this cone. Its overflow and the balance of the circulating stream were collected in a reservoir, where loss of temperature during circulation could be restored by a steam jet, and then returned to the separation box to complete the circuit. The sand settling in the first cone was allowed to run from the bottom through a valve of suitable size. It was found that by regulating the opening properly a continuous stream of wet sand tailings containing about 75% solids could be removed. Mud settlings were run out periodically from the bottom of the second cone.

The plant was ready for trial by the end of June. July was spent in working out such details as the design of the automatic hopper for metering the bituminous sand; in observing the action of the mixing machine and making alterations to its mixing blades; in working out the construction of the self-cleaning screen for catching trash in the feed to the separation box; and on other details. One carload of bituminous sand was separated during the course of this work. By August it was considered that the purpose of operations at Dunvegan Yards, namely, the working out of improvements in plant design at Edmonton where machine shop facilities and supplies were at hand, had been accomplished in so far as was practical. The plant was dismantled, machine shop work done on some of its parts, and on August 20th it was loaded on a flat car and shipped to Waterways.

Separation Plant at Waterways

A site for the re-erection of the separation plant had been decided upon beside the Mines Branch bituminous sand quarry on the Federal bituminous sand reserve on the north bank of the Clearwater river about half a mile below Waterways. Design of the new buildings and plant layout was completed by the time the equipment was taken north, so that construction work was commenced at once.

The separation plant and camp are shown in Figure 13. The bituminous sand outcropping along the river bank and the quarry from which the overburden has been stripped are seen at the left

of the picture. The towers support cables for use in handling bituminous sand to the landing and to the separation plant immediately to the right of the quarry.

The plant equipment was arranged much the same as shown in Figure 12. There is no bucket line elevating bituminous sand into the plant, as the plant is built on a side hill and the storage platform is the highest part of it. The sawdust chains feed the bituminous sand directly into the automatic meter and dumper which discharges into the mixing machine. The trough of the mixing machine is provided with a steam jacket capable of withstanding boiler pressure. The separation box is enlarged by combining the two old boxes of the original plant at Dunvegan Yards into one by setting

Figure 13—The Separation Plant and Bituminous Sand Quarry.

one upside down on top of the other and making obvious modifications. There are four cones for settling precipitated waterglass and silt from the plant water.

The plant was ready for a trial by the end of October. The mild autumn weather lasted just long enough to allow of a few days of trial operation, and runs were made on the 30th and 31st of October and the 1st of November. Eleven barrels were filled with separated bitumen and taken to Waterways for shipment to Edmonton for laboratory studies. The following day the river filled with ice. The plant was closed up for the winter and the work of the season was ended.

It was hardly to be anticipated that this plant would operate satisfactorily from the very start, and yet such proved to be the case. Much of the credit for this successful culmination of the season's operations is due to Mr. John Sutherland, foreman in charge of the undertaking.

LABORATORY STUDIES

New Laboratory Plant.

Troubles encountered in the operation of the large separation plant during 1925 were subsequently investigated in the laboratory.

The accumulation of solids in the plant water was given particular attention. The addition of a soluble salt to the plant water to form an insoluble substance with the silicate of soda and also coagulate the clay suspension was an obvious possibility. However, there was the question of whether the presence of such a salt would interfere with the efficiency of the separation process. Tests were made and the desired precipitating and coagulating effect obtained without interference with the separation process. The precipitated solids appeared to settle readily, but there was no provision in the then existing laboratory plant for testing this point.

The experience in operating the 1925 plant had shown that a better system for eliminating tailings from the plant was necessary. Bucket lines were unsatisfactory mechanically and were wrong in principle in that the tailings were elevated through the surface of the hot water where there was a layer of separated bitumen. The drawing off of the tailings from the bottom of the vessel containing them in a way similar to that used for eliminating settlings in a gravel washing plant offered possibilities. A hopper was designed for testing the idea with bituminous sand tailings. It was found that if the tailings were clean and free from trash, they would flow readily from under the water in the hopper through a small aperture without allowing the water to break through. The outflow of wet tailings contained about seventy-five percent solids.

It thus appeared that if the accumulation of silicate of soda and silt in the plant water were precipitated by addition of a salt such as calcium chloride, and the plant water and sand tailings were pumped through a series of settling cones for settling the sand tailings and precipitated solids, a means would be had for eliminating tailings satisfactorily and of keeping the plant water clean.

The old laboratory separation plant was dismantled and another plant assembled incorporating the new ideas. A diaphragm pump was attached to the bottom of the separation box and a stream of plant water containing sand tailings and precipitated solids was elevated to two settling cones in series. The overflow from the cones ran back to the separation box. The arrangement is similar to that shown in Figure 12. A batch mixer prepared batches of seventeen pounds of bituminous sand for test runs.

Bituminous sand brought from McMurray in the Spring was the freshest material that had been brought to the laboratory. It was placed in closed cans at the time of mining and was at the laboratory within a week. The importance of freshness was apparent. The material separated very well and very little silicate of soda was needed in the treatment of it. A solution of one or two-tenths percent concentration was sufficient. The new laboratory plant functioned well, the diaphragm pump handling tailings as well as water, and the cones did all that was expected, settling sand and coagulated silicate of soda and silt. The use of calcium chloride to clarify the plant water revealed no harmful effect on the efficiency of separation. The performance of the plant with its new features was most gratifying and the way was thus cleared for the remodelling of the large plant at Dunvegan Yards.

Long Series of Runs through the Laboratory Plant.

Information has been accumulating for a number of years from the making of separation runs in the laboratory plants. The influence of various factors, such as temperature, rate of flow of circulating water, concentration of treating reagents, types of reagents, etc., on separation results have been studied. All this work has been done by running batches of about seventeen pounds of bituminous sand as individual experiments. There was some question whether the information gained was directly applicable to the performance to be expected from a large separation plant in continuous operation. The separation of large quantities of material in the same supply of plant water, as is done in a plant of continuous operation might have the effect of changing the results from those observed in the case of individual batches. This point had been investigated to some extent with the laboratory plant, but a more comprehensive test was needed.

The new laboratory plant with its settling cones for clarifying the plant water was suited to the test, so the handling of about fifteen hundred pounds of bituminous sand through the plant by consecutive runs of seventeen pound batches was undertaken. The plant held sixty gallons of water, but during the course of the experiment, which lasted a number of days, an additional sixty gallons of water had to be added to replace leakage losses and water leaving the plant with the wet tailings. There were eighty-seven batch runs in the series. Results for each fifth run are given in Table IV. The bituminous sand used was from the carload procured from the McMurray Asphaltum and Oil Company at Draper for use in the Dunvegan Yard plant operations. The sand used in runs 131 to 193 was mixed with one-eighth of its weight of a seven-tenths percent solution of "BW" brand silicate of soda solution (Philadelphia Quartz Co.) and heated to a temperature of 85°C. For the remainder of the series a one and four-tenths percent solution of a silicate of soda obtained from the Royal Crown Soap Co. of Calgary was used. It contained about two-thirds the quantity of solids as the "BW" brand. The plant water was maintained at about 85°C. A quantity of calcium chloride solution was added before each run, the quantity being regulated, by observation, to the amount just sufficient to cause the plant water to settle clear.

The results of the series of runs indicate that constant re-use of the plant water does not adversely affect separation. It was found that the quantity of calcium chloride required to keep the plant water settling clear was the amount that was necessary to unite chemically with the silicate of soda used in the treatment to form the insoluble calcium silicate. The coagulation of the silt apparently required little, if any, calcium salt over and above that needed to precipitate the silicate.

TABLE IV.

Results of Analyses of the Bitumen from a Series of Consecutive Runs in Laboratory Separation Plant. Data for each fifth run are given.

Number of Run	Analyses of Separated Bitumen			
	Percentage of			Percentage Mineral Matter Calculated to Dry Basis
	Bitumen	Water	Mineral Matter	
131	63.7	34.0	2.3	3.5
136	71.0	26.5	2.5	3.4
141	74.0	21.6	4.4	5.6
146	66.8	30.3	2.9	4.2
151	75.7	20.6	3.7	4.7
156	74.8	21.8	3.4	4.4
161	62.9	33.0	4.1	6.1
166	69.0	28.2	2.8	3.9
171	72.0	24.7	3.3	4.4
176	75.5	20.6	3.9	4.9
181	79.5	16.3	4.2	5.0
186	76.3	19.9	3.8	4.7
191	76.5	21.0	2.5	3.2
196	76.6	21.8	1.6	2.0
201	75.6	22.8	1.6	2.1
206	76.0	22.6	1.4	1.8
211	79.3	18.5	2.2	2.7
216	76.6	21.0	2.4	3.0

The results shown in Table IV are typical. The one operation reduces the mineral matter associated with the bitumen from eighty-five percent or more in the bituminous sand to five percent or less in the crude separated bitumen. There is a considerable range of variation in the mineral matter content of the separated bitumen, however. Every now and then a surprisingly low result, or an unexpectedly high one, turns up and no reason for them is apparent. It was observed during the series of runs that whenever a considerable quantity of fresh water was added to the plant to make up losses, the separated bitumen from the next few runs had a high content of mineral matter.

Salt Brine Plant Water for Separation.

The result of work that is discussed in the next section suggested that the use of a strong salt brine as plant water would be advantageous if it did not interfere with the efficiency of the separation process. Consequently a number of runs were made using for plant water salt brine of various concentrations up to a twenty-five percent solution. Separation results were excellent. The content of mineral matter in the separated bitumen was as low as when no salt was used, and the water content was very much lower. On standing, the bitumen rose to the surface of the salt water and its final water content was reduced to less than ten percent. Stronger brines separated better from the bitmuen than did less concentrated ones.

Elimination of Water and Mineral Matter from Separated Bitumen.

Although the separation process under discussion gives remarkably good results, it nevertheless does not yield a separated bitumen of sufficient purity for many commercial purposes. Bitumen containing as much as thirty-five percent of water and five percent of mineral matter (cf Table IV) is not a satisfactory final product. These impurities both encumber the bitumen with useless weight from the standpoint of shipment and interfere with its usefulness. Obviously some operation subsequent to the hot water separation is needed for eliminating both water and mineral matter and producing a clean, uniform product. Much of the laboratory work of the year has been directed toward the devising of such an operation.

The logical way to get rid of the small amount of mineral matter left in the bitumen is to settle it out. To hasten settling one would naturally heat the bitumen to a temperature at which it is quite fluid. Trouble is encountered in doing this, however, since its water content causes frothing as the boiling point of water is approached. This difficulty could be avoided by using a closed settling vessel capable of withstanding considerable pressure. Boiling and frothing would be prevented by this expedient and the bitumen made as fluid as practicable.

Preliminary settling experiments using a laboratory autoclave were made and encouraging results secured. A pressure settling tank of about six gallons capacity and provided with an inside steam heater was then constructed. Good settling of mineral matter took place in this tank, but there was no reduction in the water content of the bitumen.

A number of reagents are known which break water-in-oil emulsions. Phenol is such a reagent and its effect was tried. It was hoped that it would liberate the water from the bitumen and that at a temperature of, say, 150°C, the specific gravity of the bitumen would be sufficiently above that of water to allow the water to settle. This did not prove to be the case. The phenol broke the emulsion but the water segregated in masses throughout the bitumen.

It was obvious that elimination of this water depended on creating a substantial difference in specific gravity between the bitumen and water. This was accomplished by adding sufficient dry salt with the bitumen to form a strong brine with the water present. Phenol was also added to break the emulsion. This system, in the pressure settling tank, gave excellent results. The mineral matter collected on the bottom, a definite layer of salt water came next and the bitumen floated on top. Six hours of settling in the laboratory apparatus gave a bitumen of about six percent water content and less than one percent mineral matter content. A twenty-four hour period of settling reduced the combined water and mineral matter content to less than one percent.

As settling in a closed vessel under pressure presented practical difficulties, attention was turned to the possibilities of settling at atmospheric pressure. Salt was thoroughly incorporated with the separated bitumen in a steam jacketed mixing machine in which the temperature of the mixture was raised to nearly the boiling

point of saturated salt brine. It was found that the hot mixture on standing for twelve hours at a temperature above 90°C gave a bitumen of from five to eight percent water content (including salt). If this bitumen were again mixed with salt and allowed to settle, the combined water and mineral matter content decreased to less than two percent.

When the water content of the bitumen has been reduced to less than ten percent it would be probably economical to completely remove the remaining water by evaporation. The evaporation can be done in a steam heated mixer. It has been found that the bitumen dried in this way and settled at a temperature of about 100°C gives a product containing a few tenths of one percent impurities.

The use of salt in a separation plant is commercially feasible in the McMurray neighborhood, as this is underlain by salt. A salt industry is bound to be established there shortly and consequently cheap salt will be available. In fact the very best form in which the salt could be used would be as brine from a salt well. This brine would also contain calcium and magnesium salts for the precipitation of silicate of soda and suspended mineral matter.

Laboratory studies of the elimination of water and mineral matter from separated bitumen are still proceeding. Enough progress has been made to lead to the determination of a practical procedure which can be used in connection with the large scale separation work during the coming season.

Memorandum of Agreement between the representatives of the Scientific and Industrial Research Council of Alberta and the Deputy Minister of Mines for Canada with respect to co-operation between their respective organizations for the purpose of developing commercial methods for utilising the bituminous sands of Alberta.

It is agreed that the allocation of problems of the respective parties shall be as follows:

(1) Investigation of methods of mining to be allocated to the Federal Department of Mines; this department also undertakes to deliver on cars at Waterways bituminous sand to be used for the investigation of separation processes by the other parties to this agreement.

(2) Investigation of the processes for the separating of bitumen from the sands shall be allocated to the Alberta Research Council; it is understood that this includes studies and methods of emulsifying, dehydrating and otherwise preparing separated bitumen for industrial applications.

(3) The problems of the utilization of the prepared bitumen will be dealt with by the Administrative Committee as they arise. In general it is understood that the use of these products for the beneficiation of road surfaces will be under the technical supervision of the Department of Mines; that the encouragement of the cracking or other processes for the production of gasoline or other commercial by-products will be under the supervision of the Alberta Research Council; distribution of products to other than Govern-

ment organizations for experimental purposes will be made only on the recommendation of the Administrative committee.

The Administrative Committee shall consist of: Dr. Charles Camsell, representing the Federal Department of Mines; Dr. R. C. Wallace, representing the Scientific and Industrial Research Council of Alberta; Dr. H. M. Tory, representing the National Research Council.

Edmonton, Alberta,
May 13, 1929.

To implement the above agreement the following programme was suggested for the current year.

Work to be undertaken by the Department of Mines.

Development of a quarry site as near as possible to the end of steel in the vicinity of Waterways, Alberta; the quarrying and loading on railway cars at Waterways of several hundred tons of fresh material for shipment, as required, to the separation plant of the Alberta Research Council at Dunvegan Yards; to carry out powder tests to determine a method of loosening and preparing bituminous sand for loading; to co-operate with the Alberta Research Council in locating a suitable site for a semi-commercial separation plant to be erected later; to carry on such additional related investigations as may be assigned by the Administrative Committee.

Work to be undertaken by the Alberta Research Council.

Continue laboratory investigations to test out points of design of plant that are under consideration; to further perfect methods of procedure; to recondition the existing separation plant at Dunvegan Yards and to make such modifications as laboratory investigations indicate are desirable; to produce as large a quantity of separated bitumen as is needed to determine the efficiency of the methods; to carry on tests in emulsifying and dehydrating or otherwise preparing the separated bitumen for industrial applications; on the basis of the experience gained in the operation of the preliminary plant at Dunvegan Yards to prepare and design and, as far as possible, to proceed with the erection of a semi-commercial separation plant at a locality to be designated by the Administrative Committee; to carry on such other related investigations as may be assigned by the Administrative Committee.

Work to be considered by the Administrative Committee.

Problems relating to the utilization of the prepared bitumen will have to be considered as they arise.

It is further agreed that all public announcements with respect to the above work shall emanate only from the Administrative Committee.

SOIL SURVEYS

By F. A. Wyatt

Three parties were engaged in soil surveys during the summer. The area covered by each party is indicated as follows:

Area North and West of Athabaska

J. L. Doughty had charge of the field work of this party. The territory covered by the party is located on both sides of the Athabaska river between Smith and Athabaska. It extends north beyond Calling lake and west to Slave lake. The southern boundary is from Athabaska to Flatbush. There are approximately 1½ million acres in the surveyed area. Practically all of the best soils of the surveyed area are occupied at the present time. There are a few small areas of good soil unoccupied. These are located as follows: along Deep creek, Tp. 69, R. 21; on the south side of the Athabaska river in Tp. 72, R. 25. These two areas contain about 20 quarter sections.

The second class wooded soil is considered suitable for immediate settlement despite the fact that in general it requires rather heavy clearing. This class contains about 88,000 acres of which not over 40% is occupied at present. This leaves remaining about 330 quarter sections of unoccupied land. The greater part of this class of soil is on the north side of the Athabaska river and tributary to the town of Athabaska. Most of this land is taken up for a distance of 12 to 15 miles from Athabaska. Other small areas of unoccupied land in this class are located as follows: about 14 sections east of Calling lake, about 8 sections north of Athabaska river in Tp. 72, R. 26, about 16 sections in Tp. 70, Rgs. 25 and 26, west of the 4th Meridian, and R. 1 west of the 5th Meridian.

The third class wooded soil constitutes about 70% of the entire area. There are certain local areas which contain a few quarter sections of desirable land, but in general the soil is sub-marginal and offers little promise for immediate settlement. This class of soil should not be settled until the better areas adjacent have been developed.

The surveyed area contains much swamp and muskeg (over 20% of the total). It is impossible to determine just what proportion of the muskeg area will furnish suitable farming lands, but it is thought probably very little, and this only after the swamps and shallower portions of the muskegs have been reclaimed.

From all indications, the surveyed area is quite adequately supplied with water. In certain parts of the surveyed area there is abundance of pasture. Other parts contain practically no pasture. Pasture, however, is available for more stock than can be wintered by the amount of feed at the present being produced.

AREA BETWEEN GRIMSHAW AND KEG RIVER

A. Leahey had charge of this field party. The surveyed area covered by this party is found chiefly in Tps. 85 to 104, Rgs. 21 to 25, west of the 5th Meridian. The southern boundary is 10 miles north of Grimshaw and the northern boundary near Keg river. The Peace river forms the eastern boundary and the 6th Meridian the western boundary. It is estimated that the area traversed gave information applicable to about 2 million acres.

The first and second class prairie soils are practically all taken, there remaining only a few quarter sections of these classes unsettled at present.

About 50% of the first class wooded soils are now taken. This leaves 270 quarter sections of this class still available for settlement. The greater part of the unsettled lands of this class occur in Tps. 85 and 86, R. 21. These are readily accessible since they occur relatively near the developed area around Grimshaw. A road extends to within two miles of the southern edge of this area and the northern part of the area can very easily be linked up with the Battle river highway. The above classes consist of soils which without a doubt are sufficiently fertile to insure satisfactory crop returns.

There are about 250,000 acres of second class wooded soil which is thought would justify immediate settlement. This would furnish about 1,500 quarter sections.

In addition to the above there will be small local parcels within the third class wooded areas and likewise within the muskeg areas suitable for settlement, but it is impossible to determine the extent of these areas.

About 75% of the entire area consists of soils which are considered sub-marginal, but could be used as forest and game reserves.

While most of the best agricultural land has been homesteaded mostly within the past year and a half, it is yet but little developed. There remains possibly about 1,700 to 1,900 quarter sections which are thought suitable for settlement. When developed this district should produce considerable wealth. Certain parts of the Whitemud prairie seem to be subject to frosts, but in the Battle river area there is no doubt but that much grain will be raised as a cash crop. This latter area seems to be as free from frost as any part of the Peace river district. At present there are few cattle in the surveyed area. There is considerable more summer pasture than can be utilized due to the lack of winter feed. However, when the good areas are developed much more winter feed will be available. Good summer pasture cannot be depended upon for more than 5 months at the outside. The climate does not differ materially from that of the Peace river area.

The area as far north as the Meikle river is now provided with a highway constructed during 1929.

Area Between Dunvegan and the British Columbia-Alberta Boundary

O. R. Younge had charge of this field party. The area covered by this party extends from Dunvegan to the British Columbia-Alberta boundary, and lies between the Saddle hills on the south and the Clear hills on the north. The area comprises about 2,600,000 acres. Of the prairie soils and the first class wooded soils there are almost 1,000,000 acres yet to be settled. These two classes consist of soils which without a doubt are sufficiently fertile to insure satisfactory crop returns. In the above two classes there are about 5,800 quarter sections yet to be settled, each of which contains from 120 to 140 acres of arable land.

In addition to the above two classes there are about ¾ of a million acres of second class wooded soil which is thought would justify settlement. This class contains about 4,600 quarter sections of unoccupied land. The bulk of the better soils are in a belt 5 to 15 miles wide lying north of the Peace river and extending from Dunvegan along both sides of the Eureka-Clear river systems to the British Columbia-Alberta boundary, and again on the south side of the Peace river, north and west from Spirit river. This second area comprises the north-east slope of the Blueberry plateau. Many of the areas of the better soil classes are devoid of surface water.

The better areas are not yet provided with transportation facilities, but highways leading in that direction are now under construction. It is doubtful if there exists any other single area of similar size in the north country where the percentage of unoccupied desirable soil is as great as that found in the area covered by Younge's party.

The areas covered by the three parties comprise about 6½ million acres and contain about 13,000 quarter sections suitable for settlement and not yet taken. Of these at least 3,000 quarters consist of very fertile soil and the remaining 10,000 consist of soil which is only medium in fertility.

NATURAL GAS RESEARCH

By E. H. Boomer

An account of researches projected and in progress was given in the Ninth Annual Report. Since that time, work has been principally on the line of developing technique. This report is in the nature of a progress report as a complete detailed account is at present impossible, in view of the vast amount of experimental data obtained but not yet correlated, and the incomplete nature of the researches.

Hydrogenation or Berginisation of Tar and Coal

A. W. Saddington has been carrying on investigations in the high pressure laboratory on the production of oil from McMurray tar and from Alberta coal by means of hydrogen or natural gas.

The hydrogenation of tar has progressed satisfactorily. The experiments show that hydrogen is absorbed rapidly in the presence of catalysts; the best catalyst examined being ammonium molybdate. The operation yields light crude oil, up to 80% of the weight of the original tar, considerable gas and 10 to 14% coke. This crude oil gives, after refining and distillation, a 50 to 60% yield of good anti-knock gasoline.

Experiments on the cracking of tar in the presence of a catalyst and of natural gas under high pressure do not show any absorption of the gas. They do, however, produce larger yields of oil and less coke than does straight pressure cracking. More gas is found in the retort at the end of the test than was charged in originally, but the gas yield is less than in straight pressure cracking; the methane yield, for example, being only one-tenth of that found in the absence of natural gas.

No definite results can be given on the hydrogenation of coal. This work is still confined to a determination of the best technique.

Water Gas and its Synthesis

An investigation related to the project on the chemistry of water gas, which is easily prepared from natural gas, has been carried on by H. E. Morris. The immediate objective of this work is the synthesis of ethyl alcohol. In this connection, it may be pointed out that a reaction may be investigaed in two ways: either directly by examination of the reaction leading, for example, from water gas to the desired product, ethyl alcohol, or indirectly by examination of the decomposition of the desired product to the original raw material. In the present work, as is often the case, the last method is very suitable, as the apparatus is simple and individual tests of short duration.

The decomposition of water-alcohol and carbon dioxide-alcohol mixtures has been thoroughly examined over a wide variety of catalysts. The alcohol and water mixtures show the most promise and later work has been confined to them. They decompose in two principal ways: to carbon monoxide and hydrogen (water gas) and to methane, carbon dioxide and hydrogen. The reactions are difficult to obtain independent of one another and are further complicated by a decomposition of the alcohol itself into aldehydes and related bodies, carbon and hydrogen. This work is being continued in view of the interest attached to these decompositions and the desirability of obtaining catalysts giving complete control of them. High pressure equipment is now available for investigating the direct reaction and the research has reached a stage where it is worth while to employ this procedure. It is planned to open up other investigations shortly on the possibilities of water gas as a starting point for other syntheses.

Pyrolysis or Heat Treatment of Natural Gas

A comprehensive investigation has been opened by P. E. Gishler on the pyrolysis of natural gas. The pyrolysis, or passage of the gas through hot tubes, has been attacked intermittently for some years and is of particular interest in Alberta.

Experiments have been confined recently to one type of tube only and to the temperature range 800°C to 1200°C. High temperatures and high rates of flow give maximum yields of solid and liquid hydrocarbons. Conversion of 3 to 4% of the gas to heavy oil, napthalene and benzene in the approximate ratio 2:1:1 are easily obtained with a minimum coke formation and promotion of hydrogen. These conditions allow of recirculation of the gas with consequent further yields of oil. The process is not advantageous from one standpoint, that of ethylene production, as the experiments show that the best yields of oil involve minimum yields, 3 to 4%, of ethylene. Ethylene gas would be a product of great potential value, as from it many valuable substances can be made. This work has not been extended to a variety of tubes, principally because of unsolved difficulties involved in condensing the heavy oils which appear in the treated gas as a very persistent fog. For the same reason exact data as to yields are lacking and measured conversions are all too low.

LIST OF PUBLICATIONS

OF

THE SCIENTIFIC AND INDUSTRIAL RESEARCH COUNCIL OF ALBERTA.

EDMONTON, ALBERTA

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By Dr. J. A. Allan, Professor of Geology, University of Alberta.

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No. 2 (1920); pp. 138+14. Supplements the information contained in Report No. 1.

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